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Volume I.

ROYAL AIR FORCE
SIGNAL MANUAL

PART IV

Prepared by direction of the Minister of Aircraft Production,

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Promulgated by order of the Air Council,

W. G. S. G. G. G.

AIR MINISTRY

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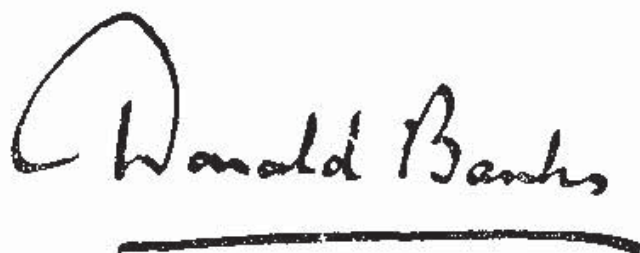
Volume I

SIGNAL MANUAL

PART IV

Issued for the information and guidance of all concerned.

By Command of the Air Council,


Donald Banks

AIR MINISTRY

December, 1938

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Volume I

The amendments promulgated in the undermentioned Amendment Lists have been made in this publication.

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„ 2. TRANSMITTER-RECEIVERS

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SECTION 1

TRANSMITTERS

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TRANSMITTER T.70

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TRANSMITTER T.70

(Stores Ref. 10A/7755)

INTRODUCTION

1. Transmitter T.70 is a ground station transmitter, employing a master-oscillator, and is designed for continuous wave, interrupted continuous wave, or radio-telephonic transmission on the frequency bands 6,000 to 2,500 kilocycles.

2. The transmitter incorporates a master-oscillator valve, an amplifying valve, a modulator valve and a sub-modulator (or speech amplifying valve). Temperature control is not fitted, but by allowing the temperature within the master-oscillator chamber to reach a steady state before making the final tuning adjustments, it is possible to work within very small limits of frequency variations due to this cause.

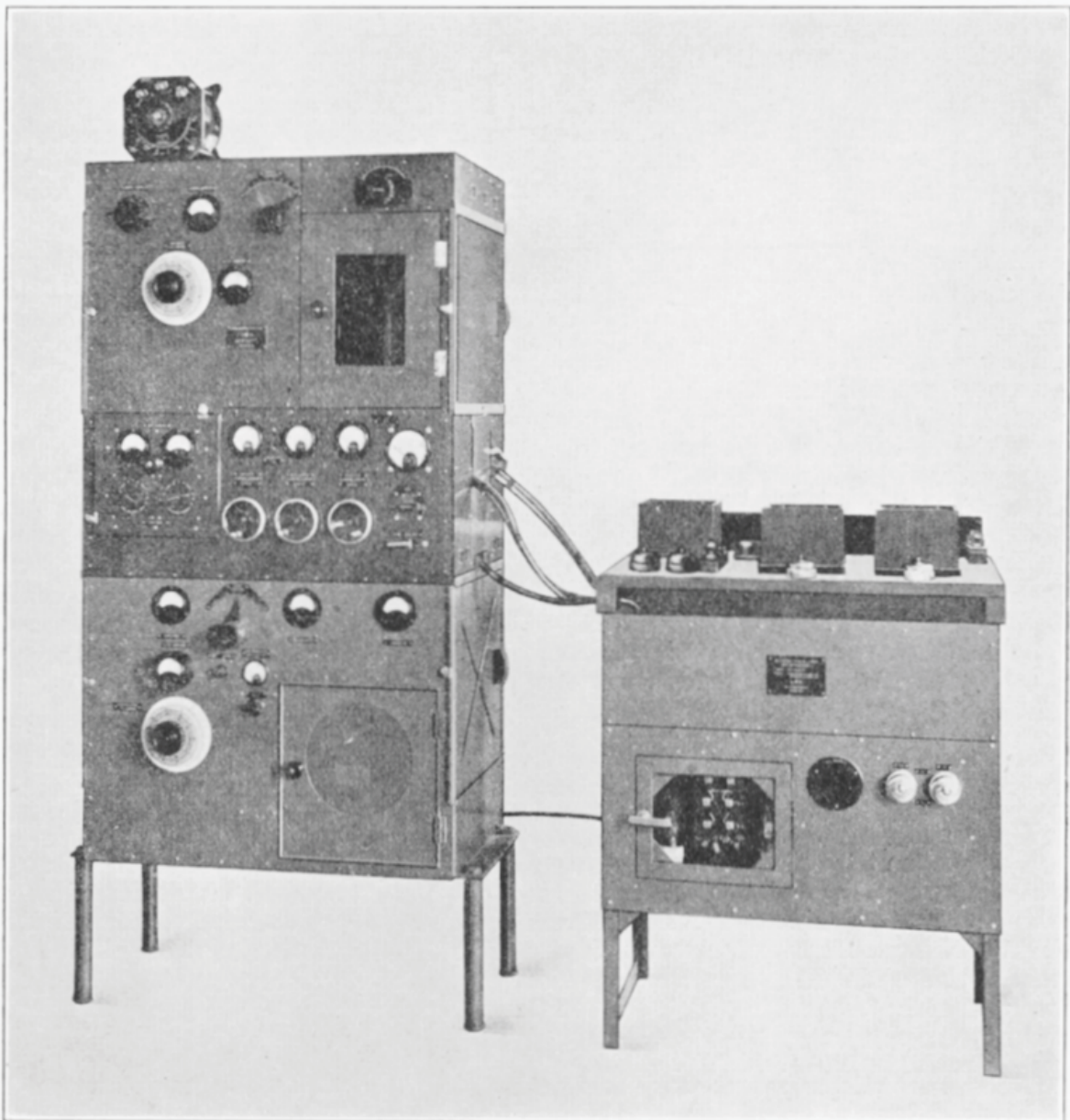


FIG. 1. Transmitter T.70 and rectifier, type B.

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3. To minimize frequency variations when C.W. is being radiated, provision is made in the wiring for the use of an entirely separate H.T. supply to the master-oscillator, the latter being constantly energized whilst the amplifier supply is keyed. Where the bulk of the work of the transmitter is R/T, supply is by means of a special self-contained unit known as Rectifier, type B (Stores Ref. 10A/8067) operating from the standard A.C. mains and providing a rectified and smoothed 3,000 volt H.T. anode supply and a 20 volt A.C. filament supply. The transmitter is shown installed with such a unit in fig. 1. Where A.C. is not available the standard 2,000 volt generator is used for H.T. supply.

4. The transmitter is provided with a multiple contact selector switch which makes all the necessary changes when moved into any one of its three positions "R/T", "C.W." or "I.C.W." It introduces the modulator and sub-modulator valves in the first position, cuts them out and introduces a keying circuit in the second position, and introduces an interrupter in the third position.

5. Radiation of telephony from a remote position over a land line is also provided for, the operation of changing from a local microphone to the line being performed by a conveniently placed switch.

6. The transmitter is built into an upright, three section, duralumin cabinet, approximately 6 ft. high by 2 ft. 8 in. by 1 ft. 8 in., with the controls and indicating instruments mounted on the front. The necessary grid bias arrangements are included in the cabinet and also the rotary interrupter for I.C.W. transmission. The weight of the transmitter alone is approximately $2\frac{3}{4}$ cwt.

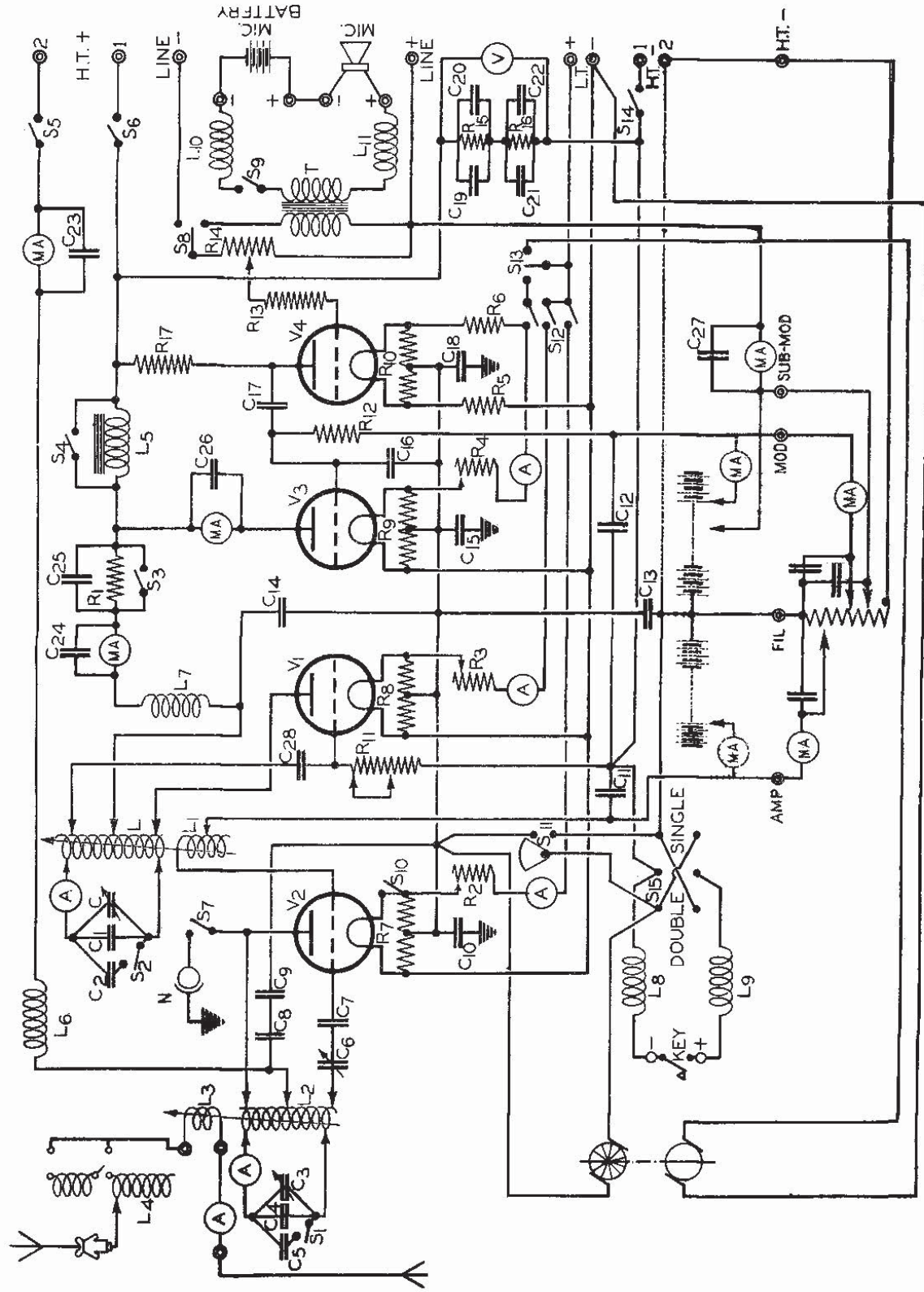
GENERAL DESCRIPTION

7. The master-oscillator circuit oscillates at a frequency determined by the settings of its inductance and capacitance. Coupled to the anode inductance is a coil which is connected in the grid circuit of the amplifier valve. The frequency of the amplifier circuit is therefore governed by that of the master-oscillator circuit. The anode circuit of the amplifier valve is, in turn, coupled to the aerial coil to which the amplified oscillatory currents are transferred, causing radiation at the desired frequency. It is obviously desirable that the amplifier circuit shall have no tendency to self-oscillation but shall function only as an amplifier of the oscillatory current transferred to it from the master-oscillator. Feed-back in the anode-grid circuit of the amplifier valve is therefore guarded against by the provision of an adjustable neutralizing condenser connected between the grid and a tap on the anode inductance. By proper adjustment of this device the R/F voltages occurring as a result of the inter-electrode capacitance of the valve are opposed by equal and opposite voltages *via* the neutralizing condenser.

8. To facilitate setting of the neutralizing device a neon lamp is provided, together with a special switch. The operation of the switch breaks the filament circuit of the amplifier valve and places the neon lamp in the anode circuit. Minimum glow in the lamp indicates correct neutralizer setting.

9. When the selector switch is placed in the C.W. position, the master-oscillator and amplifier valves only are in operation, the filaments of the modulator and sub-modulator being open-circuited. The control choke in the anode circuit of the master-oscillator valve is short-circuited and the key is introduced (H.T. switch in "double" position and separate H.T. supplies connected) between the H.T. negative lead and the cathode of the amplifying valve. The operation of the key does not affect the master-oscillator, the amplifier valve circuit only being made and broken.

10. When the selector switch is placed in the I.C.W. position the modulator and sub-modulator valves are still cut out and the control choke in the anode circuit of the master-oscillator remains short-circuited. A contact is closed which starts up a motor-driven



CONDENSERS (μF)	
C1	.00036 (max)
C2	.00023 (max)
C3	.00036
C4	.00023 (max)
C5	.00004
C6	.0001
C7	.002
C8	.002
C9	.01
C10	.01
C11	.01
C12	.01
C13	.01
C14	.01
C15	.01
C16	.01
C17	.01
C18	.01
C19	1.0
C20	1.0
C21	1.0
C22	1.0
C23	1.0
C24	1.0
C25	.5
C26	1.0
C27	1.0
C28	.001
RESISTANCES (ohms)	
R1	10,000 or 30,000
R2	4
R3	4
R4	4
R5	7
R6	7
R7	80
R8	80
R9	80
R10	80
R11	60,000 (max)
R12	50,000
R13	2 M Ω
R14	500,000
R15	5 M Ω
R16	5 M Ω
R17	500,000

FIG. 2 THEORETICAL CIRCUIT DIAGRAM

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interrupter, and another contact opens and introduces the interrupter disc (which was previously short-circuited) in series with the key. The operation of the key now causes radiation of interrupted continuous waves.

11. When the selector switch is placed in the R/T position the filament circuits of the modulator and sub-modulator valves are closed, bringing these valves into operation. The short-circuit is removed from the control choke, the microphone circuit is completed, the motor interrupter is stopped and the key and interrupter disc short-circuited. The key is now inoperative and all four valves have their H.T. circuits complete. Speaking into the microphone now causes speech currents to be impressed on the sub-modulator valves and these are, in turn, passed on considerably amplified to the modulator valve. Owing to the well known "choke control" action, the anode potential of the oscillator valve is varied (hence the amplitude of the aerial oscillations) in accordance with the original sound vibrations at the microphone, causing radio-telephonic radiation.

12. A theoretical circuit diagram of the complete transmitter is given in fig. 2. V_1 is the master-oscillator valve, V_2 the amplifier valve and V_3 and V_4 the modulator and sub-modulator valves respectively.

13. The oscillatory circuit of the master-oscillator valve comprises an inductance L and condensers C and C_1 , the condenser C being variable. A third condenser C_2 of fixed capacitance is provided and is placed in parallel with C and C_1 , by means of a link, when working on the lower frequency band. The inductance L has three tapplings, one of which is taken directly to the anode of the master-oscillator valve. Another is taken through a fixed condenser C_{23} to the grid of the master-oscillator valve, and the third tapping is the H.T. feed. In this feed is connected a milliammeter, R/F choke L_7 , a resistance R_1 shunted by the condenser C_{25} and an iron-cored inductance L_5 . Switches S_3 and S_4 are arranged on R_1 and L_5 respectively for the purpose of short-circuiting them for different transmission requirements.

14. The inductance L_1 in the grid circuit of the amplifier valve V_2 is inductively coupled to the inductance L , the coupling being variable. In the anode circuit of the amplifier valve is an inductance L_2 in parallel with which are two condensers C_3 and C_4 , C_3 being variable. As in the master-oscillator circuit a third condenser C_5 of fixed capacitance is provided which can be placed in parallel for the lower frequency band by means of a link. Three tapping points are provided on the inductance L_2 , the first being directly connected to the anode of the amplifier valve, the second being taken through the R/F choke L_6 , and through a milliammeter to H.T. positive. The third lead is taken through the neutralizing condenser C_6 and fixed condenser C_7 to the grid of the valve. From the H.T. feed tapping two condensers C_8 and C_9 are connected in series to the filament line, and a neon lamp N is connected through the switch S_7 to earth for neutralizing purposes.

15. The aerial circuit comprises the inductance L_4 and L_3 . The inductance L_4 is in two portions and a connecting link permits one portion or both to be included, depending upon the frequency requirements. The inductance L_3 which is in series with L_4 is inductively coupled to the amplifier inductance L_2 , the coupling being variable.

16. Valves V_3 and V_4 are the modulator and the sub-modulator valves for radio-telephony. A microphone circuit including the transformer T , choke coils L_{10} and L_{11} , microphone and battery is connected to the grid circuit of the sub-modulator valve V_4 , which is in turn resistance-capacitance coupled to the modulator valve V_3 . The anode of the valve V_3 is fed through the iron-cored inductance L_5 from the H.T. line which simultaneously feeds the master-oscillator valve thus effecting modulation by the "choke control" method.

17. The switch S_8 permits either the local microphone circuit or the remote microphone circuit to be connected across the resistance R_{14} . This resistance is provided with a variable contact which is connected through the resistance R_{13} to the grid of the valve V_4 , and speech voltage input to the grid-filament circuit of the valve may thus be varied from zero to maximum.

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The anode of this valve is fed through a resistance R_{17} , in order to drop the voltage to the correct value and is coupled to the grid of the modulator valve through the condenser C_{17} , the lower end of the associated resistance R_{12} being taken through a milliammeter to a tapping on the grid-bias arrangement. A condenser C_{16} is connected across the grid-filament circuit of the modulator valve and a condenser C_{13} is connected from the tapping to H.T. negative.

18. A second tapping is taken from the grid-bias arrangement through a milliammeter, which is shunted by the condenser C_{27} , to provide the necessary bias for the valve V_4 , the circuit being through the resistances R_{14} and R_{13} . The amplifier valve V_2 is biased from the same source, a milliammeter being similarly connected in the circuit. The grid base line of the master-oscillator is fixed by means of the adjustable resistance R_{21} . The value of the resistance included can be varied between zero and 60,000 ohms by means of a short-circuiting link. Condensers C_{11} and C_{13} act as by-pass shunts for the grid-bias circuits. The filaments of the valves are heated normally from a 20 volt A.C. circuit, and the filaments are shunted by the resistance R_7 , R_8 , R_9 and R_{10} respectively. The centre-points of the resistances are earthed separately through condensers C_{10} , C_{15} and C_{18} , with the exception of that on the oscillator valve.

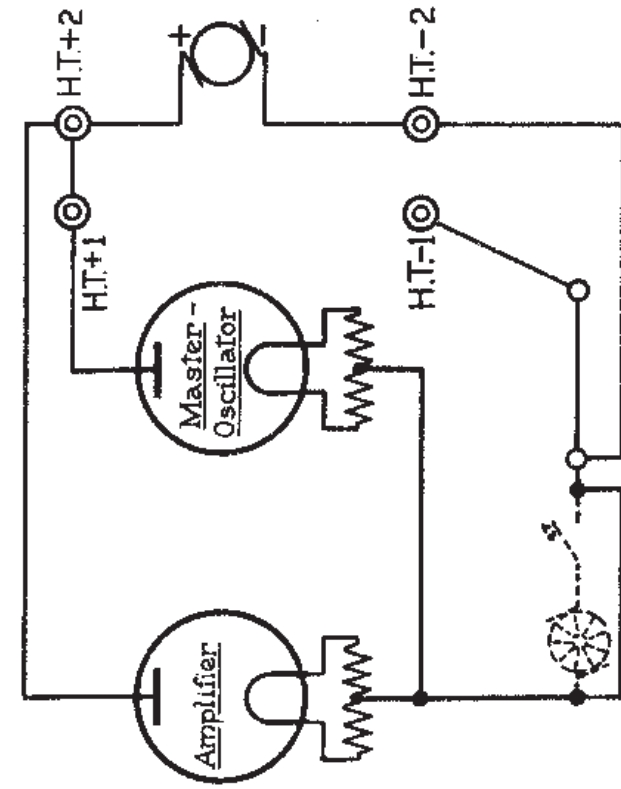
19. The filament circuits of the amplifier, oscillator and modulator valves all include ammeters, and rheostats R_2 , R_3 and R_4 are provided for the purpose of setting the filament current. An additional switch is provided in the amplifier circuit to enable the circuit to be broken for neutralizing purposes. The current in the sub-modulator valve filament circuit is not variable, the resistances R_5 and R_6 being included in the circuit to maintain the current at the required value. The switch S_{13} enables the filament circuits of the sub-modulator valves to be broken when R/T is not required.

20. Referring to fig. 3 it will be observed that the H.T. connections are so arranged that the H.T. supply to the amplifier valve and oscillator valve may be entirely independent of one another. Two H.T. positive terminals marked H.T. + 1 and H.T. + 2 and two H.T. negative terminals marked H.T. - 1 and H.T. - 2 respectively, are provided. The switch S_{15} , located in the amplifier compartment, enables the necessary changes to be made in the connections of the amplifier and master-oscillator valves for common or separate H.T. supply. When R/T is being radiated the switch is placed in the "single" position, and when C.W. or I.C.W. is being radiated the switch is placed in the "double" position. In the "single" position both amplifier and oscillator anode circuits are fed from a common H.T. positive terminal, and the H.T. negative lead is connected to the cathodes of both amplifier and oscillator valves thereby energizing both valves. In the "double" position (when two separate H.T. supplies are connected to the appropriate terminals) the oscillator is continuously energized when the key is open, but the amplifier is energized (from an independent supply) only when the key is closed.

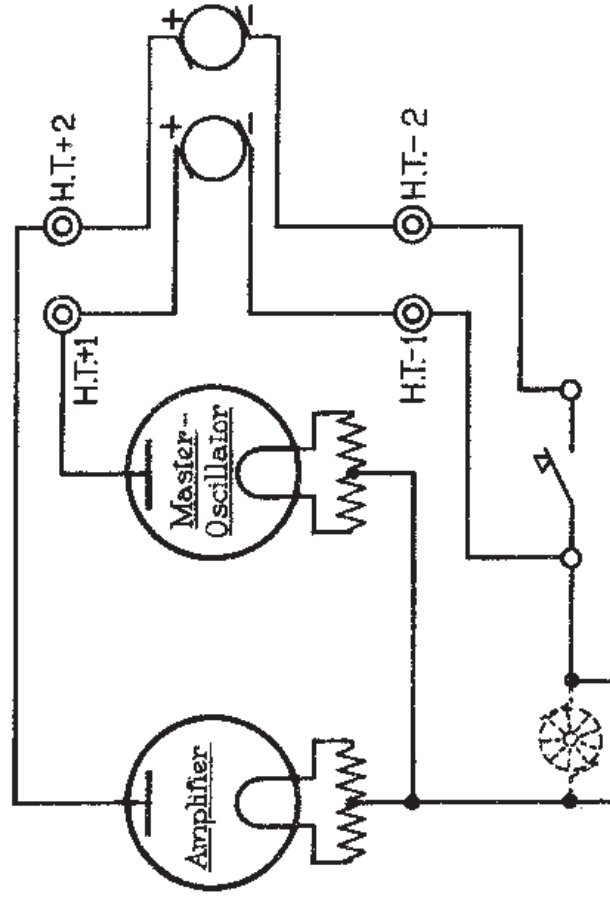
21. In fig. 2 a number of switches are shown separately at various points in the circuit. Actually several of these are arranged for simultaneous operation. For example, the H.T. switches S_{14} , S_5 and S_6 are operated by the movement of a single handle; similarly the switches S_7 and S_{10} are so coupled that when S_{10} is opened the filament circuit of the amplifier is broken, and movement of the switch handle through the remainder of its travel closes S_7 , connecting the neon lamp in circuit.

22. The three-position selector switch, when moved into the C.W. position, closes S_4 thereby short-circuiting the control choke, opens the left-hand side of S_{13} thereby breaking the filament circuits of the modulator and sub-modulator valves, closes the first contact of S_{11} which short-circuits the interrupter (leaving the key in circuit), opens the right-hand side of S_{13} which opens the interrupter motor circuit, and opens S_9 which opens the microphone circuit.

23. In the I.C.W. position the switch S_4 is closed and S_{13} (left-hand side) is open as before, but the switch S_{11} is opened thus removing the short-circuit from the interrupter, and S_{13} (right-hand side) is closed thereby starting up the interrupter motor.

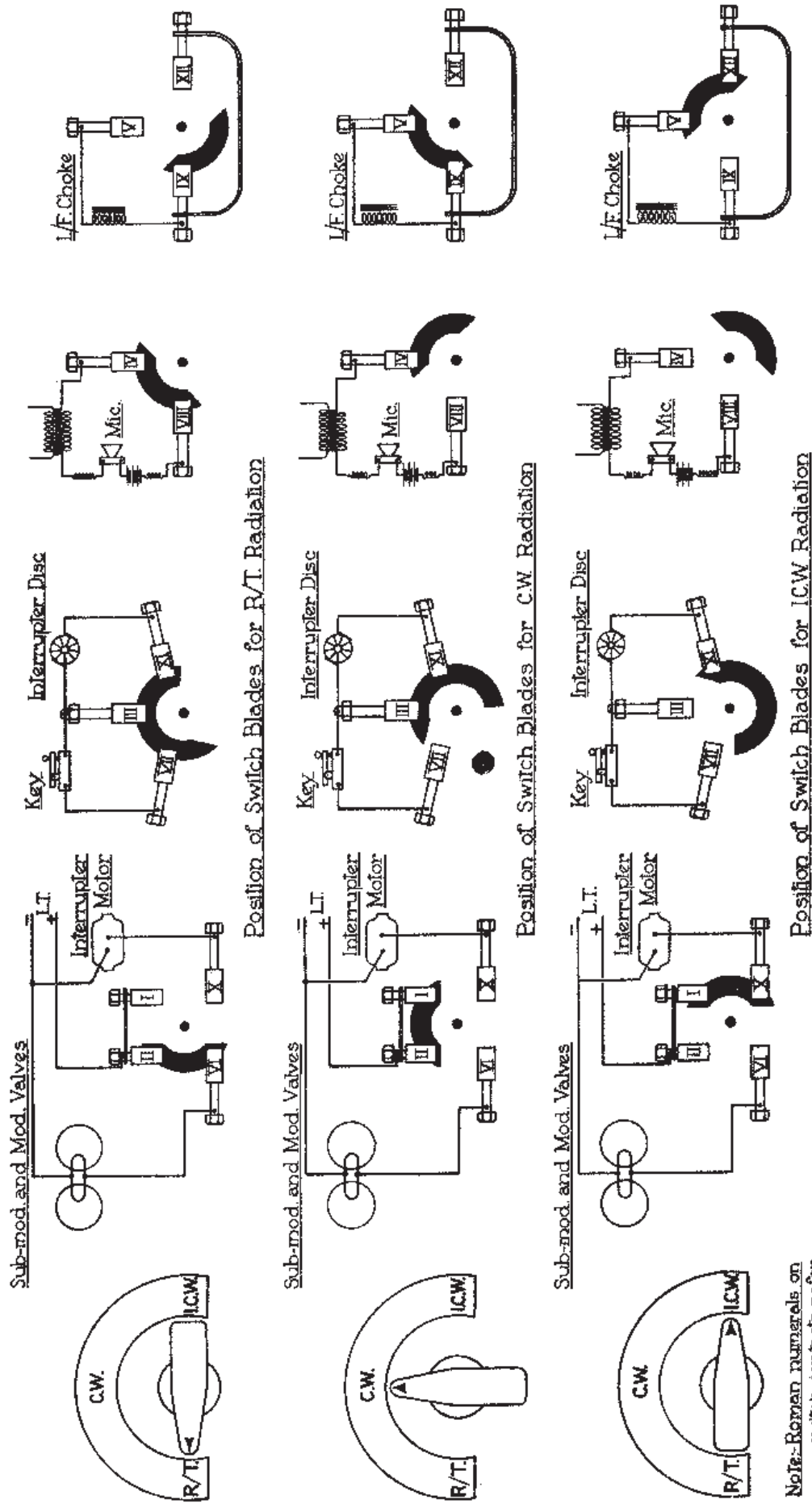


H.T. Switch in "Single" Position for R/I,
Common H.T. Supply.



H.T. Switch in "Double" Position for W/I,
Separate H.T. Supply.

FIG. 3 ALTERNATIVE H.T. SUPPLY



Note: Roman numerals on switch contacts refer to connections as wiring diagram (Fig 2)

FIG. 4. CIRCUIT CHANGES EFFECTED BY SELECTOR SWITCH

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24. In the R/T position switches S_{13} (left-hand side), S_{11} (second contact) and S_9 are closed and the following circuit changes are effected. The filament circuits of the modulator and sub-modulator valves are closed, the key and interrupter are short-circuited and the microphone circuit is closed. The switches S_4 and S_{13} (right-hand side) are opened thereby putting into circuit the control choke and opening the circuit of the motor interrupter. The circuit changes effected by the selector switch are clearly shown in the simplified diagram (fig. 4).

25. The resistance R_1 is interchangeable, 30,000 ohms being required for R/T and 10,000 for C.W. and I.C.W. transmission. In the bench wiring diagram (fig. 10) a 10,000 ohm resistance is in place. The resistance unit not in use is housed in a pair of clips fitted in the base of the bottom chamber just inside the door.

26. When the transmitter is required to operate on the higher frequency band with the standard 6-wire "T" type cage aerial, an aerial series condenser is required, and condenser type 7 (Stores Ref. 10A/2951) is suitable for this purpose. It is shown in position on the top of the transmitter in fig. 1. The condenser is of the glass enclosed variable type. It has a maximum capacitance of approximately $\cdot 0011 \mu\text{F}$. and the scale with which it is equipped is engraved with two sets of graduations, one being in degrees (0-180) and the other in jars of capacitance ($\cdot 05$ to $\cdot 95$).

CONSTRUCTIONAL DETAILS

27. The transmitter (see fig. 1) is built into a rectangular duralumin frame supported on four tubular feet, the overall height of the transmitter being approximately 6 ft. 3 in. It is divided horizontally into three compartments known as top, middle and bottom chambers respectively, the division between the middle and bottom chambers taking the form of a metal screen having terminals carried in insulating bushes.

28. The top and bottom chambers are provided with sliding side panels which can be completely removed, and hinged doors are provided on the front of these two compartments. The front door of the top chamber is provided with a glass window and the front door of the bottom chamber has a circular window fitted with gauze. The main terminal board (see fig. 7) is situated under a removable panel on the side of the middle chamber.

29. In the top chamber is housed the amplifier valve complete with its inductances and tuning apparatus. In the middle chamber are situated the switches, grid-bias arrangements, rheostats and a number of indicating instruments. The master-oscillator valve, modulator valve and sub-modulator valve with their associated apparatus are housed in the bottom chamber. Also in this chamber is the motor interrupter for I.C.W. transmission. Bench wiring diagrams of the three chambers are given in figs. 8, 9 and 10.

30. In fig. 5 is given a view of the front of the transmitter. In the top left-hand corner is the aerial tuning control (3). This consists of a moulded dial graduated from 0 to 100, which operates the variable tapping on the aerial inductance. The instrument (14) on the right of the aerial tuning condenser is the aerial ammeter. It is a thermo-ammeter reading 0 to 8 amps. and is connected in the aerial circuit. Next to this is the aerial coupling adjustment (4) which consists of a moulded knob carrying a pointer moving over a scale graduated from 0 to 90. The spindle is extended through the panel and carries the coupling coil (2, fig. 6). On the extreme right of the top of the panel is the neutralizing condenser adjustment (6), the dial of which is graduated from 0 to 120. The closed circuit ammeter (15) is situated near the centre of the upper panel, it is a thermo-ammeter reading 0 to 12 and is connected between the inductance and the condenser in the closed circuit. On the left of this is the amplifier closed circuit tuning adjustment (1), the moulded handle of which carries a transparent scale graduated from 0 to 200. Rotation of this handle operates the variable condenser through a bevel gearing.

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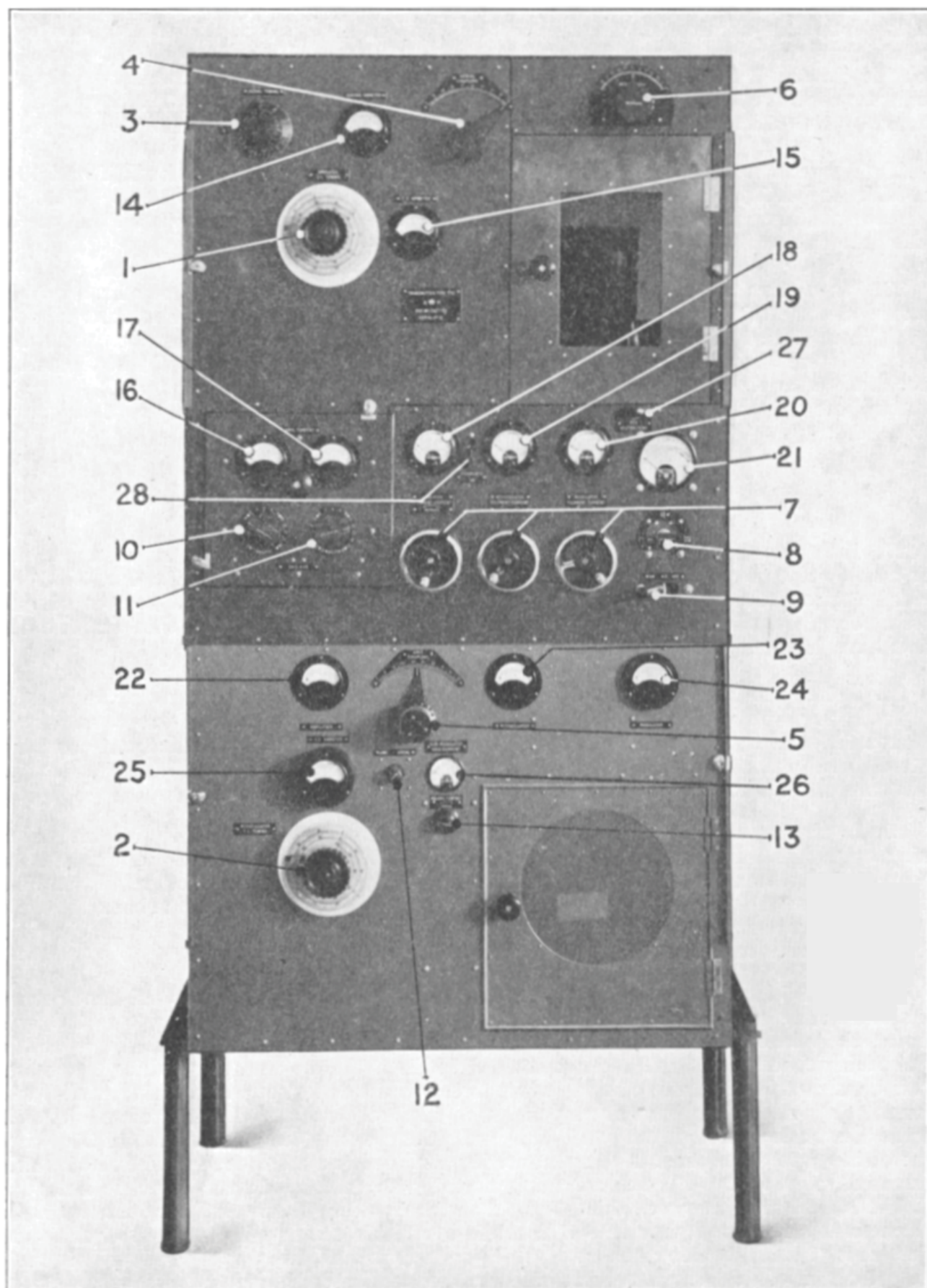


FIG. 5. Transmitter T.70, front of panel.

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31. The middle section of the transmitter is provided with a front panel composed of synthetic-resin varnish-paper board on which are grouped six meters, six switches and three rheostat handles. The two meters on the left are milliammeters reading 0-100 and 0-30 respectively. The left-hand meter (16) is connected in the grid circuit of the amplifier valve and the other meter (17) is connected in the grid circuit of the modulator valve for the purpose of indicating when grid current is flowing. These two meters together with the switches seen immediately beneath them are mounted upon a rectangular panel which forms the front of a drawer containing two dry batteries for grid-bias on the amplifier and modulator valves. That for the amplifier is a 300-volt battery, the applied voltage being adjustable by means of a switch (10) in steps of 20 volts from 40 to 300. That for the modulator is a 130-volt battery, the voltage being adjustable by means of the switch (11) in steps of 6 volts, from 60 to 130.

32. A modification has been introduced whereby transmitters working on A.C. supply derive the necessary grid-bias voltages automatically from a tapped resistance connected in the common H.T. negative and grid circuits. The modified wiring is shown in the theoretical circuit diagram fig. 5, whereas the battery bias method is shown dotted. The automatic grid-bias unit improves the performance of the transmitter in that troubles due to gradual deterioration of the batteries are eliminated. Furthermore, battery maintenance and the possibility of failure due to high resistance is removed.

33. The modifications for automatic grid-bias are made in the following manner. After switching off the A.C. supply and withdrawing the existing battery bias draw, the upper rear cover of the transmitter is removed. The four bolts and four connections securing the contact panel are undone and the contact panel with which the draw engaged is removed. A new 5-pole contact panel is secured in place using the same bolts and fixing holes. The terminals marked AMP., MOD. and SUB.-MOD. are connected up as before. A.P. 1186/A.64 gives information on possible modifications to the 5-pole contact panel before fitting.

34. The two leads marked H.T.—2 are removed from the terminal board and connected together and the free end of this lead is connected to FIL. on the new contact panel. The terminal marked H.T.—2 on the terminal board is connected to H.T.—2 on the new contact panel. After the new grid-bias unit is placed in position the rear cover of the transmitter is replaced. The terminals H.T.+1 and H.T.+2 on the terminal panel are connected together externally and joined to H.T. positive of the supply. The terminal H.T.—1 is disconnected and H.T.—2 is connected to H.T. negative of the supply.

35. To the right of this drawer are the three ammeters (18), (19) and (20) in the filament circuit of the amplifier, master-oscillator and modulator valves respectively. Between the first and second filament ammeters is the filament switch (28). Beneath the ammeters are the three filament rheostat handles (7). The larger meter (21) is the H.T. voltmeter reading 0 to 3,500 volts and above this is the neutralizing switch (27) for breaking the filament circuit of the amplifier when carrying out the operation of neutralizing. The selector switch (8) is marked for three positions R/T, C.W. and I.C.W. and effects the necessary circuit changes to enable the three different forms of transmission to be made. The switch beneath this is the main H.T. switch (9) which when placed in the off position breaks both sides of the H.T. supply.

36. The lower section of the transmitter carries, on the front panel, five meters, a switch, a grid-coupling coil control, a master-oscillator tuning control and a volume control. The amplifier milliammeter (22) reads 0-500, the master-oscillator milliammeter (23) reads 0-250 and the modulator milliammeter (24) reads 0-250. These milliammeters are connected in the anode circuits of the respective valves. The remaining two meters on the lower section are the ammeter (25) reading 0-12, connected in the oscillatory circuit, and the milliammeter (26) reading 0-5 connected in the grid circuit of the sub-modulator valve. The grid-coupling control (5) is capable of being turned through 90 degrees and varies the coupling between the amplifier and the master-oscillator. The switch (12) is for the purpose of changing over from local to remote microphone,

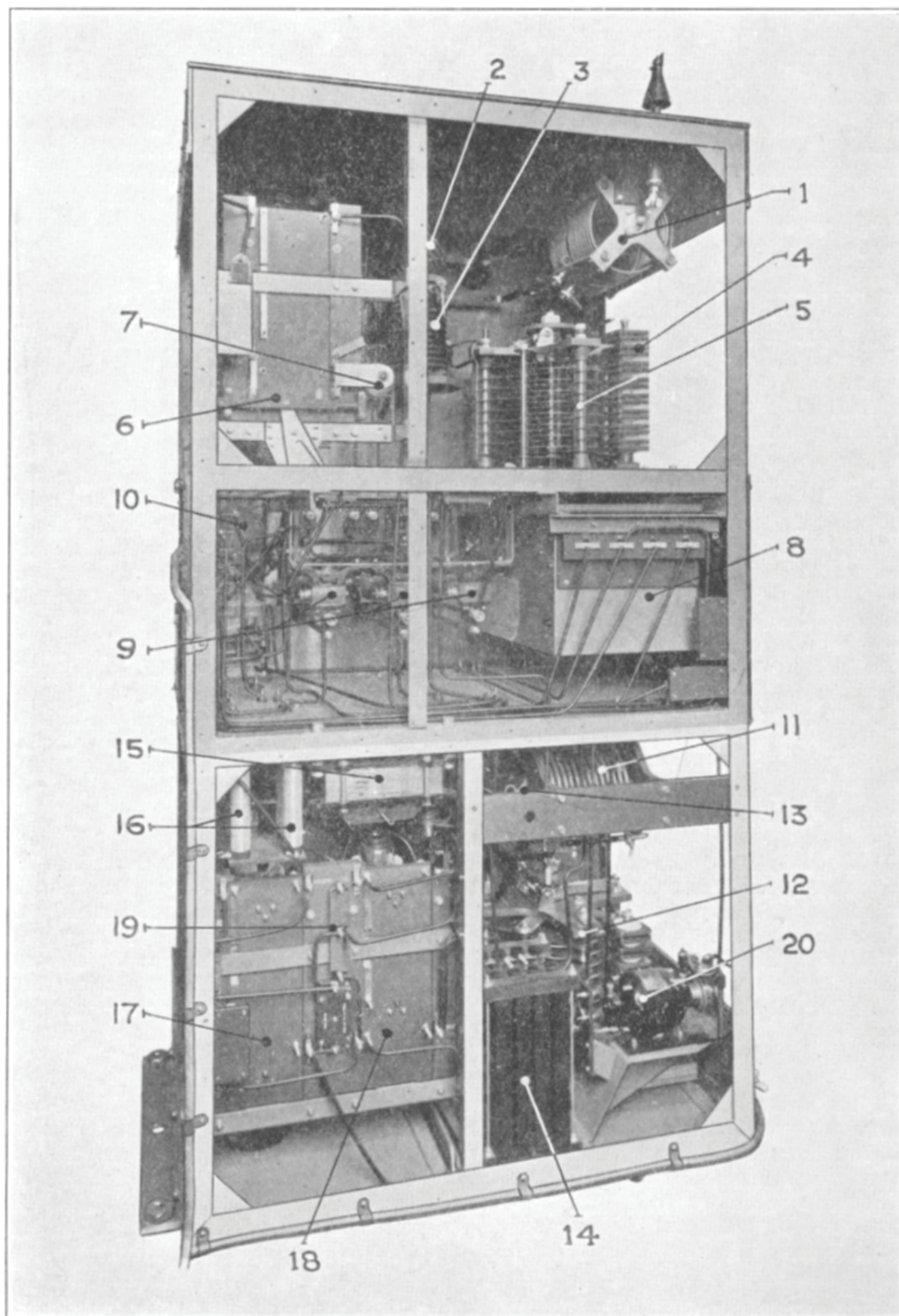


FIG. 6. Transmitter T.70, rear view.

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and the volume control (13) is interposed between the microphone circuit and sub-modulator valve. The master-oscillator closed circuit tuning control (2) is similar to that fitted in the top section for the amplifier closed circuit tuning—rotating a condenser through a bevel drive in a similar manner.

37. Referring to fig. 6 the coil (1) is the aerial inductance coil which is constructed of copper tube on an insulating former. This coil has two sections one of which can be isolated by means of a link. In the illustration the link is shown in the open position. In the centre of the coil is a spindle which carries a contact operating around the turns of the coil, the spindle being actuated by the knob (3, fig. 5).

38. From the aerial inductance coil a copper strip is taken to the aerial coupling coil (2) the other end of which is connected through an ammeter (14, fig. 5) to the counterpoise terminal. The coupling coil which is also constructed of copper tube is capable of being rotated through 90 degrees by means of the control (4, fig. 5). Immediately beneath the aerial coupling coil is the amplifier closed circuit inductance coil (3), across which are connected the adjacent condensers, (4 and 5) in series with the closed circuit ammeter (15, fig. 5). The condenser (5) is specially constructed and consists partly of fixed and partly of movable vanes. The minimum capacitance is approximately $\cdot 00011 \mu\text{F}$. and the maximum approximately $\cdot 00036 \mu\text{F}$., adjustment being made through a bevel drive operated by the control handle (1, fig. 5) on the front of the panel.

39. The component (4) carried on the side of the adjustable condenser is a packing condenser consisting of 8 sections clamped together giving a total capacitance of approximately $\cdot 00023 \mu\text{F}$. This is connected in parallel with the adjustable condenser for certain frequencies by means of the link which can be seen at the top of the adjustable condenser.

40. On the left of the top chamber is the amplifier valve panel. The valve itself can be clearly seen in fig. 4. Carried on the rear side of this panel is the switching device (6) which enables the amplifier filament circuit to be opened and a neon lamp (7) to be connected from the anode of the amplifier valve to earth, when carrying out the neutralizing operation.

41. The switch consists of a bar of insulating material on which are carried two contacts spaced approximately 6 in. apart. This bar is mounted in guides and is capable of being moved endways by means of a rack-and-pinion device operated from the front of the panel by the handle (27, fig. 5).

42. It will be observed that when the bar is in the extreme left-hand position, as shown, the left-hand contact closes the filament circuit. When the bar is moved to the right, the left-hand contact is opened. Further movement of the bar causes the right-hand contact to close, thereby connecting the anode of the valve to one side of the neon lamp, the other side of which is permanently connected to earth.

43. In the middle chamber can be seen the drawer (8) which contains the grid-bias batteries, or automatic grid-bias unit. The connections from the grid-bias batteries or from the unit are taken out through spring contacts, the back of the drawer being provided with knife contacts which engage with jaws mounted on an insulating contact bar against which the drawer stops when pushed into place. Terminals are provided on the contact bar to enable the necessary connections to be made to the spring jaws. The front of the drawer can be seen in fig. 5 and a diagram of the internal connections of the grid-bias switches (10 and 11, fig. 5) for both types of grid-bias is given in fig. 11. The three rheostats (9) are in the filament circuits of the amplifier, master-oscillators and modulator valves, and are wound on slate formers with a maximum resistance of 4 ohms. The sliding contacts are operated by handles (7, fig. 5) through worm drives. In the left-hand upper corner of the chamber can be seen the H.T. voltmeter (10). Beneath this is located the "R/T, C.W., I.C.W.", selector switch, and beneath this is the H.T. on and off switch. A theoretical diagram of the selector switch is given in fig. 4. The H.T. change-over switch for separate or common supply is located on the cross member at the top of the middle chamber but is accessible only through the front door of the top chamber. A theoretical diagram showing the changes effected by this switch is given in fig. 3.

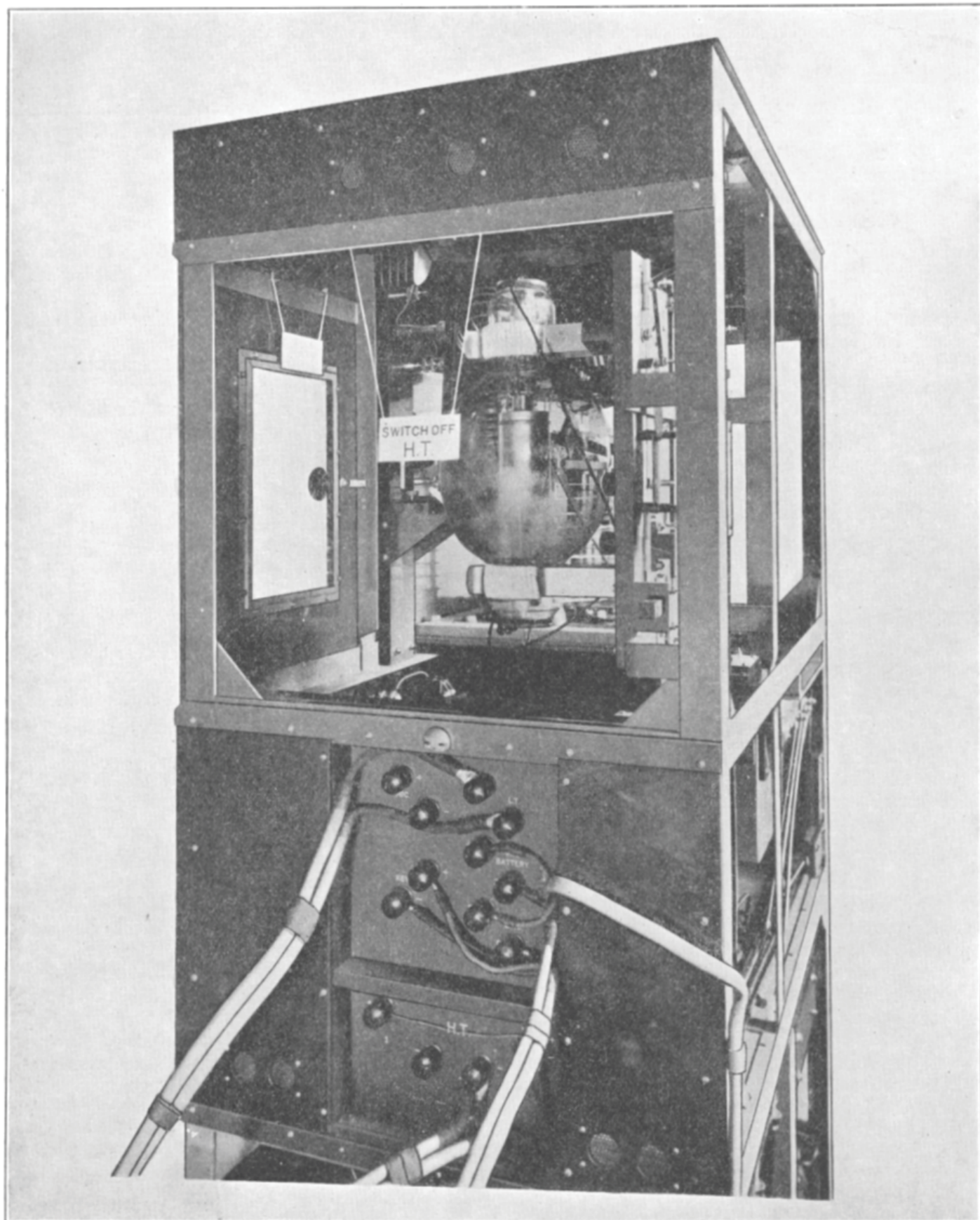
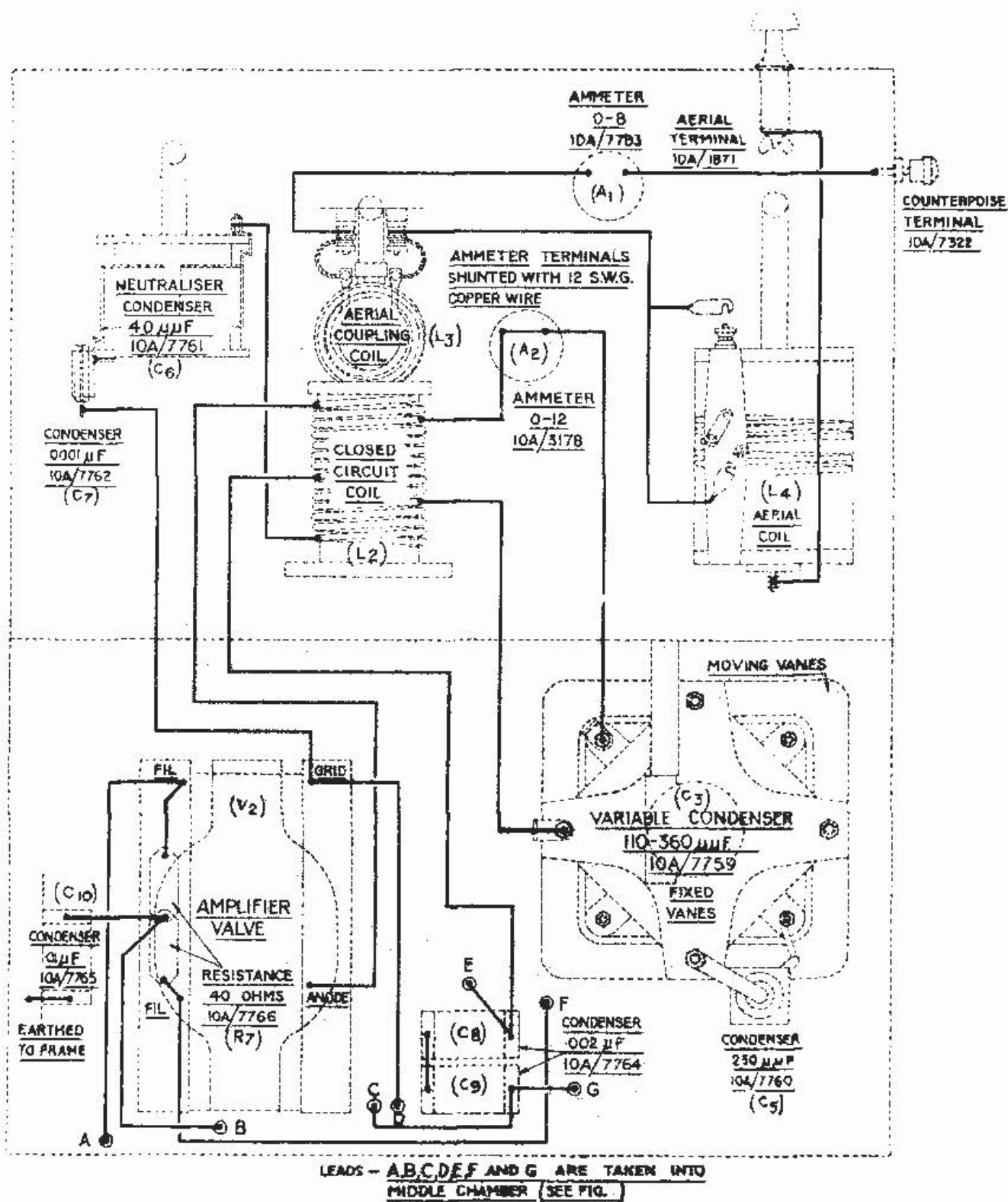


FIG. 7. Transmitter T.70, side view.

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NOTE: ANNOTATIONS THUS (L4) REFER TO THE CORRESPONDING ANNOTATIONS IN FIG. 2.

FIG. 8. BENCH WIRING DIAGRAM, TOP CHAMBER

44. In the bottom chamber can be seen the master-oscillator inductance coil (11) with its associated condensers (12). These are of similar construction to those used in the aerial closed circuit and installed in the top chamber. The grid coupling coil (13) is operated by the control handle (5, fig. 5), and an ammeter (25, fig. 5) is connected in the master oscillator closed circuit. The group (14) is a series-parallel group of 4 μ F. condensers with two 5-megohm resistances and is connected between H.T. +1 and H.T. -1 on the dead side of the H.T. switch. The group corresponds to C_{19} , C_{20} , C_{21} , C_{22} , and R_{15} and R_{16} in fig. 2. On the left-hand side of the bottom compartment may be seen the L/F choke (15), next to which are the two microphone and two key R/F chokes (16) and the grid-bias by-pass condensers.

45. The master-oscillator, modulator and sub-modulator valves are all housed in the bottom chamber, the master-oscillator and modulator valves being carried on valve bases (17 and 18) which take the form of upright panels held in position by turn-buttons. Each panel is provided with valve clips and terminals for the electrodes, the latter being provided with spring contacts so that the whole panel may be easily plugged into place or withdrawn. The top of the modulator valve can be seen beyond the panel (18). The sub-modulator valve is carried on a separate base near the master-oscillator tuning condenser (12).

46. The resistance (19) is an 80-ohm centre-tapped resistance connected across the filament circuit of the modulator valve. All four valves have similar resistances across their filament circuits. The grid leak for the master-oscillator which consists of 12 sections each having resistances of 5,000 ohms, is installed just inside and above the front door of the bottom chamber. A short-circuiting link is provided on the leak to enable a suitable value of resistance to be obtained for any setting of the transmitter.

47. The interrupter motor (20) is designed to run on either A.C. or D.C. (20 volts). Two pairs of leads are provided, one pair being connected up for D.C. and the other pair for A.C. The shaft of the motor carries a ten-segment interrupter disc.

VALVES AND POWER SUPPLY

48. There are four valves used in the transmitter. A valve, type V.T. 5B is used as a master-oscillator. One V.T. 4B is used as an amplifier. The modulator is a valve, type D.E.T. 3 and the sub-modulator is a V.T. 25. The H.T. and L.T. voltages required for the valves are obtained from the rectifier, type B, (Stores Ref. 10A/8067). A rectifier and smoothing circuit is incorporated in the unit which is described elsewhere in this publication. The rectifier type B is generally placed near the transmitter, connections being made by means of flexible leads.

49. When the T.70 is adapted for operation by remote controls, the remote controls, type 5, are generally used and are mounted on the top of the rectifier unit. A reference to fig. 1 will show the manner in which the various components are usually arranged.

OPERATION

50. In fig. 12 is given a diagram and a table indicating master-oscillator and amplifier inductance settings. The three ranges are numbered 1, 2 and 3 and the sockets are coloured to facilitate rapid changes in the settings. The sockets in use on range 1 are coloured blue, those in use on range 2 are plain and those in use on range 3 are red. Where the same socket is used on two ranges the socket is given two colours, e.g., a condenser connection is made to No. 3 turn for both range 1 and range 3. The socket is therefore coloured blue and red. The inductance coils illustrated in fig. 12 have the connections appropriate to range 1.

51. In Tables 1, 2 and 3 are given typical settings and instrument readings for the 6,000-4,286 kc/s. band (radiating radio telephony), the 4,286-3,000 kc/s. band (radiating C.W.), and

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for the 3,000–2,500 kc/s. band (radiating R/T, I.C.W. and C.W.). From these tables can also be ascertained whether or not the packing condensers are required, whether full or half aerial coil is required, and what value of anode feed resistance is to be used for the master-oscillator.

Adjustments for C.W. operation

52. See that the H.T. switch is in the off position. Connect up the two H.T. sources to the appropriately labelled terminals. Place the H.T. supply switch, inside the amplifier compartment, in the "double" position. See that the grid-bias switches are at "0".

53. From the information given in fig. 12 and in the tables, set the master-oscillator tuning condenser, grid coupling, amplifier tuning condenser and neutralizing condenser to the appropriate settings for the desired frequency. Place the packing condenser links in the appropriate positions, and if half aerial coil only is called for, the link should be opened and the strip connection removed from the outer end of the coil and connected at the end of the first half of the coil from which the link has been removed.

54. Set the aerial coupling to zero and the selector switch to the C.W. position. Now turn the filament rheostats as far as they will go in a clockwise direction. Next place the filament switch in the on position and adjust each filament rheostat to give the required current for the particular valve (Amplifier, up to 6 amps.; oscillator, 5.2 to 5.6 amps.; each adjusted for maximum aerial current) and set the amplifier grid-bias switch to stud 8. Switch on the H.T. supply to the master-oscillator only, and set the transmitter main H.T. switch to on.

55. The main voltmeter, master-oscillator milliammeter, and closed circuit ammeter only should give readings when the correct state of oscillation of the master-oscillator circuit is obtained.

56. Operate the neutralizing switch which opens the amplifier filament circuit and connects the neon lamp to the anode circuit. Turn the neutralizing condenser to "0" and tune the amplifier by means of the glow in the lamp. Switch on the H.T. supply to the amplifier. Rotate the neutralizing condenser and note the scale readings at the extreme positions of the condenser for which there is no glow in the lamp. The mean of these values is the correct neutralizing position.

57. Return the neutralizing switch to its original position thereby closing the amplifier valve filament circuit and opening the neon lamp circuit. Depress the key to complete the amplifier circuit and tune the amplifier closed circuit until the current as indicated by the amplifier closed circuit ammeter is a maximum. Set the aerial coupling to, say 45 degrees and tune the aerial circuit. Re-adjust the grid coupling and aerial coupling until the maximum aerial current is obtained. The aerial coupling should be as loose as possible to avoid the "double hump" effect in tuning.

58. With the key closed, check the frequency. It may be found that a slight change of frequency has occurred. If a change has occurred, re-adjust the master-oscillator tuning and repeat the above operations.

59. Re-adjustment of the master-oscillator circuit tuning can be made quite simply in the following way. Suppose that the required frequency is 4,800 kc/s. and that as a result of first adjustment the frequency has changed to 4,762 kc/s. (a difference of 38 kc/s.). By reference to the tables it will be found that in this particular region of frequencies 255 kc/s. is equal to 20 divisions of the master-oscillator condenser scale, so that 38 kc/s. is equal to 3 divisions. It is only necessary therefore to set the master-oscillator tuning condenser back on the scale by this amount and re-tune throughout to reproduce a frequency of 4,800 kc/s. in the aerial circuit.

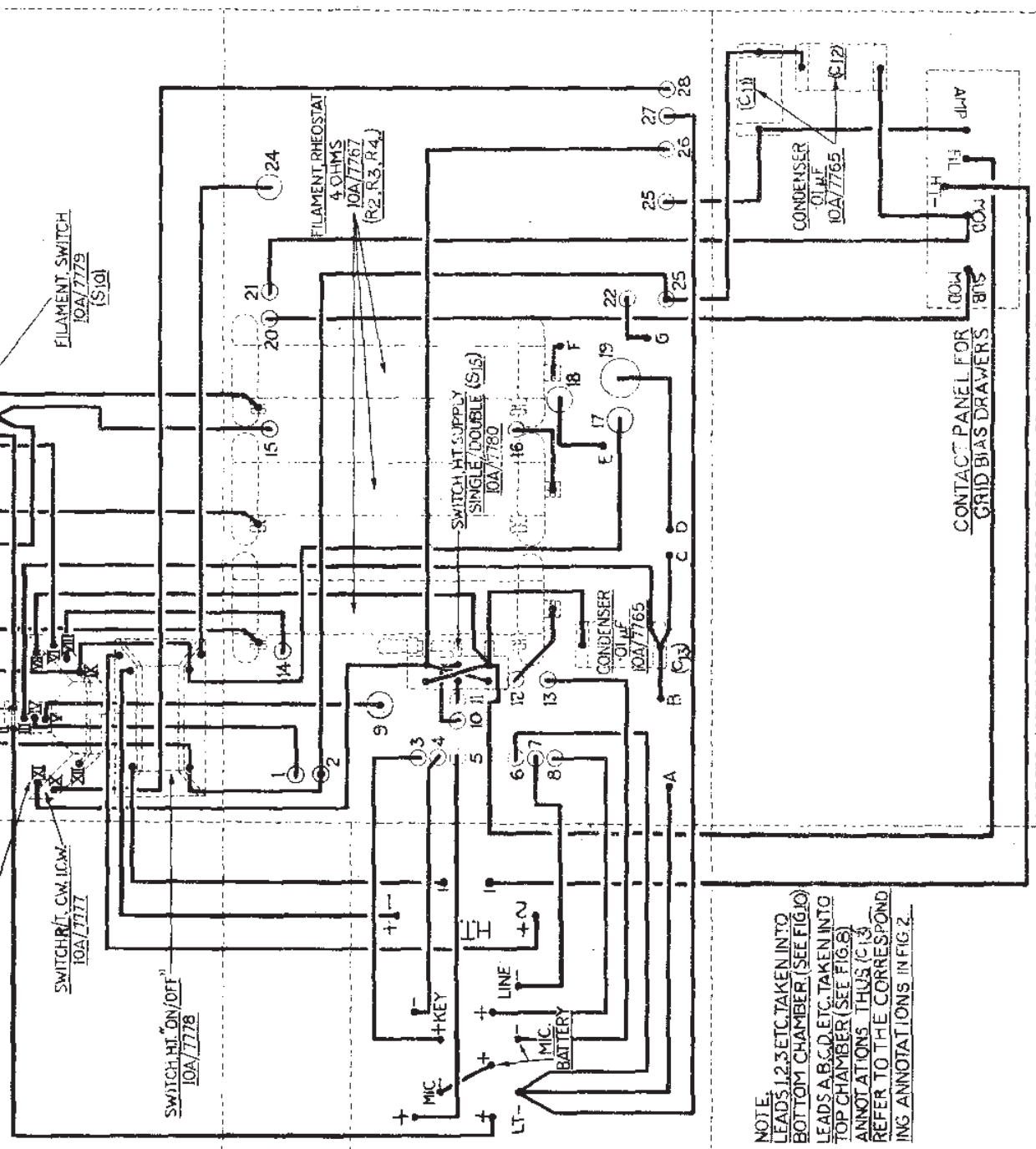
60. It may sometimes be found that at a certain frequency setting of the master-oscillator a harmonic resonance occurs in the grid coupling coil. This is mainly confined to the higher frequencies of the band covered by the transmitter and is due to the necessity for providing

VOLTMETER 0-3500
10A/7784
AMP
MODULATOR

AMMETER 0-10
10A/7782
MASTER-
OSCILLATOR

AMMETER 0-10
10A/7782
AMPLIFIER

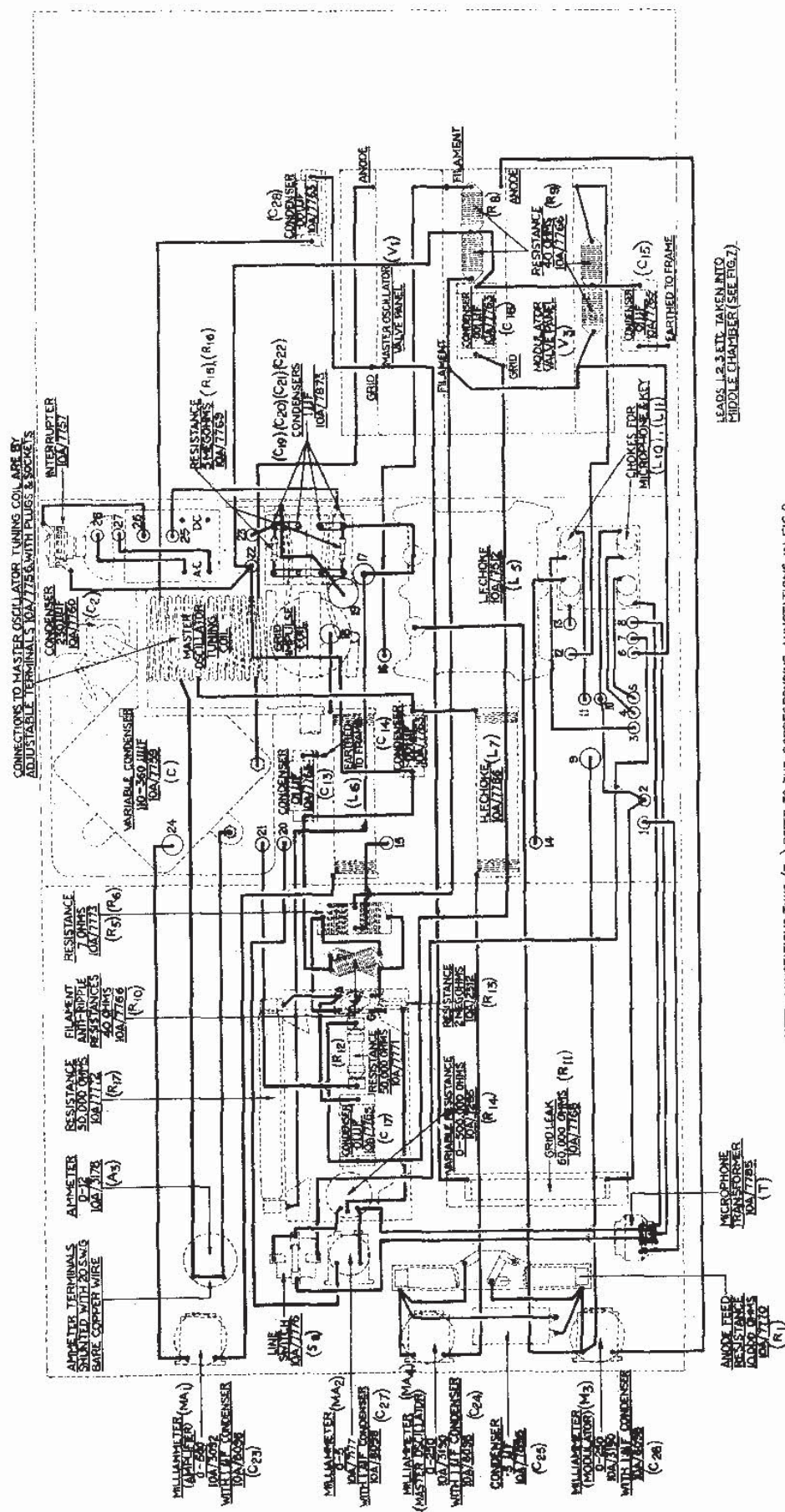
ROMAN NUMERALS REFER
TO CONNECTIONS ON
THEORETICAL DIAGRAM
OF SWITCH (SEE FIG. 4)



NOTE:
LEADS 1, 2, 3, ETC. TAKEN INTO
BOTTOM CHAMBER (SEE FIG. 10)
LEADS A, B, C, D, ETC. TAKEN INTO
TOP CHAMBER (SEE FIG. 8)
ANNOTATIONS THUS (C13)
REFER TO THE CORRESPOND-
ING ANNOTATIONS IN FIG. 2.

FIG. 9 BENCH WIRING DIAGRAM, MIDDLE CHAMBER

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NOTE. ANNOTATIONS THUS (R₁₇) REFER TO THE CORRESPONDING ANNOTATIONS IN FIG. 2.

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large inductance in the coupling coil for the lower frequency portion of the band. When, owing to this effect, difficulty is experienced in the process of tuning, or neutralizing, or both, a change of coupling tap will usually effect an improvement.

61. The master-oscillator valve should not take more than 130 milliamps. at 3,000 volts. If the anode current at 3,000 volts is much in excess of this value switch off and increase the resistance of the grid-leak.

62. The amplifier valve is capable of dissipating 450 watts continuously on the anode in which state the anode glows with a bright red colour. This is the normal working state of the valve and is in no way objectionable. In connection with the transmitter T.70 however, this state is sometimes associated with excessive grid current. This latter must be avoided by increasing the amplifier bias or decreasing the grid coupling or both. When the grid coupling value is changed the neutralizing condenser may require to be reset.

Adjustments for I.C.W. operation

63. Adjust the transmitter for C.W. working as described above and set the selector switch to the "I.C.W." position. If more power is required than is obtainable with these adjustments, try the effect of increase of coupling (both grid and aerial). If the bulk of the work of the transmitter is to be on I.C.W. it may be advisable to lower the anode tap of the master-oscillator circuit, but this should never be done where there is likelihood of a quick change-over to R/T transmission being required.

Adjustments for R/T operation

64. In order to obtain proper modulating conditions the procedure outlined in the following paragraphs should be observed. Assuming that the transmitter has been properly adjusted for C.W. on the desired frequency, switch off and withdraw the master-oscillator anode feed resistance. Set the selector switch to R/T and the modulator bias switch to stud 16. Now switch on and adjust the amplifier bias until the amplifier anode current milliammeter reads 15-20 mA. with H.T. tap 2, or 30-40 mA. with H.T. tap 3. Switch off and insert the 30,000 ohm anode feed resistance.

65. Switch on and adjust the modulator filament current to 4 amperes (*see* para. 71, modulation of the carrier due to A.C. ripple). Adjust the grid and aerial coupling for maximum aerial current. (Re-tuning of both amplifier and aerial circuits will probably be necessary.)

66. Re-adjust the bias on the modulator valve until this valve is dissipating just less than 250 watts. For an anode voltage of 3,000 volts, for example, the anode current should be slightly less than 83 mA.; for a voltage of 2,500 volts the anode current should be slightly less than 100 mA. and for a voltage of 2,000 volts the anode current should be slightly less than 125 mA. and so on.

67. The sub-modulator valve should normally require no adjustment. It is advisable, however, to check the sub-modulator bias occasionally with a voltmeter, and it is a good plan to glance at the sub-modulator valve after switching on. Any heating up of its anode is an indication that the bias is insufficient.

68. Read the value of aerial current carefully. Leaving all other adjustments untouched (except the modulator bias which must always be adjusted to limit the anode dissipation to 250 watts) reduce the grid coupling until the aerial current has fallen to half its former value. Proper conditions for modulation should now obtain.

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69. When a common H.T. supply is to be used the switch must be put to the "single" position, the H.T. source connected to the H.T. +1 and H.T. -1 terminals, and the two H.T. positive terminals connected together. The terminals H.T. -1 and H.T. -2 must *not* be connected together otherwise arcing may take place when the H.T. switch is required to break a heavy current.

70. When all the adjustments described above have been satisfactorily made, the modulation should be checked by means of a Modulation Indicator. If a Modulation Indicator is not available the following method may be usefully employed. Speak into the microphone and note the readings on the aerial ammeter or on the amplifier closed circuit ammeter. For correct modulation these ammeter readings should rise with modulation (22 per cent. rise for 100 per cent. modulation, 6 per cent. rise for 50 per cent. modulation). At the same time there should be little or no movement of the pointers of the amplifier and the modulator anode current instruments. In the case of the amplifier anode current, an increase indicates that the grid coupling is insufficient or that the bias is too great, or both. Similarly a decrease of anode current indicates the converse. A small amount of movement of the pointer of the anode current instrument may be neglected. When checking the modulator anode current the adjustment to be aimed at is one that gives as little movement of the pointer as possible. A movement of 10 milliamps. should be regarded as the absolute maximum allowable.

71. If it is found, by observation of the Modulation Indicator, that more than 5 per cent. modulation of the carrier, is present owing to A.C. ripple, an increase or decrease of the filament current of the modulator valve may effect a considerable improvement. This is permissible up to a value not more than 20 per cent. or to such a value that the anode current of the modulator valve is not appreciably altered.

72. The amplitude of the speech voltage impressed on the grid of the sub-modulator valve can be controlled by means of the volume control. The volume is increased by rotating the handle of the control in a clockwise direction. The maximum volume allowable is that which produces the 10 milliamps. change mentioned above. Except for extreme ranges a low volume setting should be used.

73. The upper limit of frequency of the transmitter is given as 6,000 kc/s. When necessary this upper limit may be raised to 6,666 kc/s. by making the following adjustments.

Master-oscillator coil.

Connection.	Colour.	Turn.
Anode	Black	1
Condenser	Red-black	4
H.T. +	Black	9
Condenser	Blue	10
Grid	Black	13

Amplifier coil.

Connection.	Colour.	Turn.
Anode	Blue	3
Condenser	Blue-white	2
H.T. +	Black	7
Condenser	Blue	9
Neutrodyne	Black	14

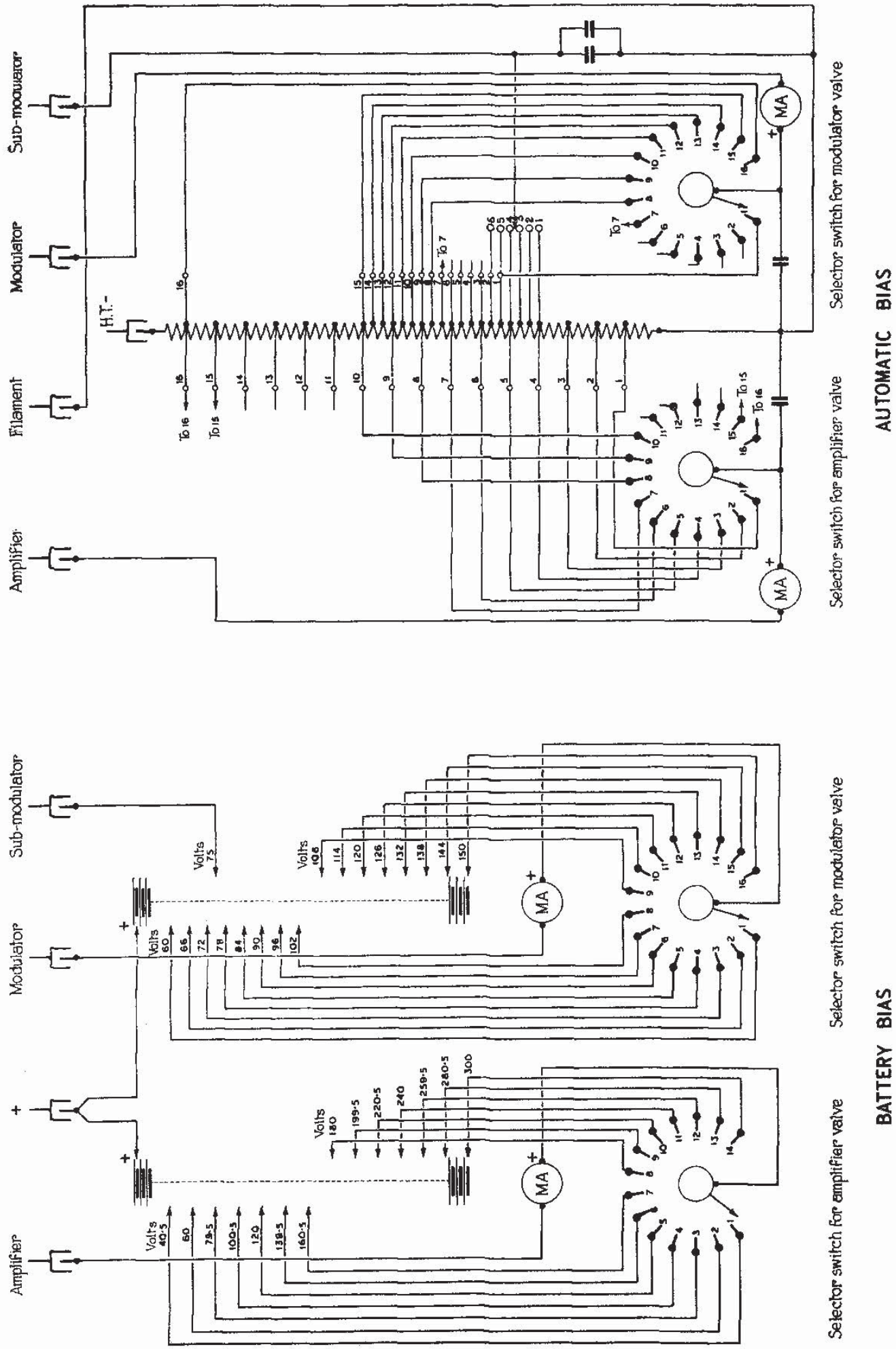
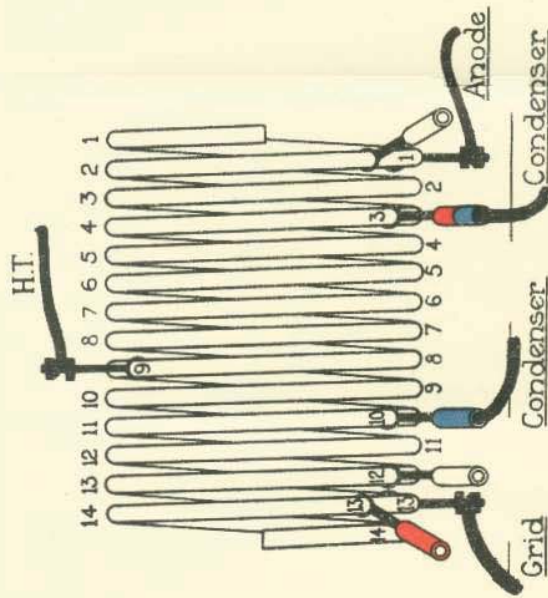
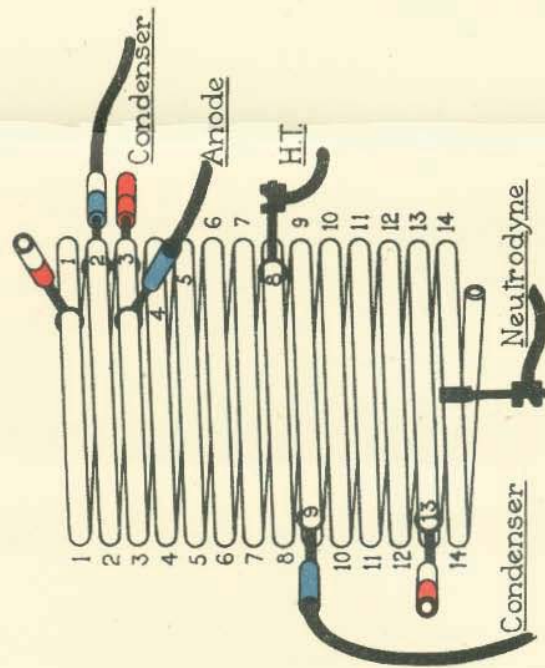


FIG. 11, GRID BIAS SWITCH CONNECTIONS



Master-Oscillator Coil
(Set up for Range 1)



Amplifier Coil
(Set up for Range 1)

Range 1 (blue)

<u>Master-Oscillator</u>	<u>Amplifier</u>
Anode on turn	1 Anode on turn
Condenser on turn	3 Condenser on turn
H.T. on turn	9 H.T. on turn
Condenser on turn	10 Condenser on turn
Grid on turn	13 Neutrodyne on turn

Range 2 (plain)

<u>Master-Oscillator</u>	<u>Amplifier</u>
Anode on turn	1 Anode on turn
Condenser on turn	1 Condenser on turn
H.T. on turn	9 H.T. on turn
Condenser on turn	12 Condenser on turn
Grid on turn	13 Neutrodyne on turn

Range 3 (red)

<u>Master-Oscillator</u>	<u>Amplifier</u>
Anode on turn	1 Anode on turn
Condenser on turn	3 Condenser on turn
H.T. on turn	9 H.T. on turn
Condenser on turn	13 Condenser on turn
Grid on turn	13 Neutrodyne on turn

FIG. 12 SETTING OF MASTER-OSCILLATOR AND AMPLIFIER INDUCTANCES

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74. When rapid changes of frequency are required between 4,300 and 6,000 kc/s. the operation is facilitated by the existence of a table which shows sets of adjustments for the frequencies to be used. Table 4 shows typical sets of adjustments for four frequencies between 4,300 and 6,000 kc/s. A similar table is to be prepared for each transmitter for the particular frequency on which it will be worked and is to be prominently displayed near the transmitter.

75. With practice it is possible to change to any frequency for which the adjustments are known in about 60 seconds. Whilst changing the frequency, the modulator grid-bias control should be set to a maximum. The aerial current, *i.e.*, the unmodulated carrier should not be less than 2 amps. for each frequency adjustment.

With remote control

76. When it is desired to operate the transmitter from some remote position, remote controls, type 5, (Stores Ref. 10A/9523) may be used. Both W/T and R/T remote control are possible with this unit, which is usually mounted on top of the rectifier, type B, near the transmitter.

77. Remote controls, type 5, consist of a board on which are mounted three relays, a repeating coil, a metal rectifier, a transformer, a key, two single tumbler switches and two coupled tumbler switches. The apparatus at the operating end is the same as is usually used for remote control operation and the whole system is described elsewhere in this publication.

78. Two terminal strips are provided on the remote control unit. The terminals on the right-hand strip are connected to the transmitter while the terminals on the left-hand strip are connected to the incoming A and B lines from the operating end and also to the rectifier. The simplified diagram, fig. 14, shows the manner in which the various units are connected up. When it is desired to operate the transmitter remotely, all that is necessary is to ensure that the switch (12, fig. 5) is in the "line" position and that the switch (8, fig. 5) is in the position which gives the type of radiation required, *e.g.*, R/T, C.W. or I.C.W. When R/T is being radiated, the coupled tumbler switches on the remote control unit should be in the R/T position. When C.W. or I.C.W. is being radiated, the coupled tumbler switches should be in the W/T position. The H.T. and L.T. to the transmitter are switched on and off by means of the two relays on the remote control unit, which are in turn controlled from the operating end.

PRECAUTIONS AND MAINTENANCE

79. While carrying out any adjustments to components inside the transmitter, every precaution must be taken to avoid contact with live parts. In no circumstances must a door or panel be opened unless the H.T. switch has first been placed in the off position. Labels bearing the words SWITCH OFF H.T. are hung at various places in the transmitter and these must never be removed.

80. When the transmitter is used for R/T, an anode resistance of 30,000 ohms is included in the H.T. feed to the master-oscillator valve. It has been found that, except when maximum efficiency is required, this value of resistance also suffices for C.W. and I.C.W. transmissions.

81. When the transmitter is in use for R/T, C.W. and I.C.W., this resistance is not to be changed with a change in the type of radiation unless maximum efficiency is required in the transmission of C.W. and I.C.W. Where the transmitter is never used for R/T, the alternative 10,000 ohm anode resistance (Stores Ref. 10A/7770) is to be used permanently for both C.W. and I.C.W.

82. Since the rectifier, type B, is used with this transmitter, the usual precautions peculiar to this unit should be observed. For example, the valves used are of the mercury vapour type and, should any mercury have come in contact with the filaments, the valves will be seriously damaged if the H.T. is switched on before this mercury is removed. To avoid this damage therefore the filaments should be switched on for not less than ten minutes before the H.T.

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83. Care should be exercised that the correct fuses are fitted in the rectifier, and also that the relay type K is correctly adjusted. Details of the various precautions necessary for the rectifier unit will be found in the appropriate chapter which appears elsewhere in this publication.

84. If the grid-bias for the transmitter, as explained in para. 30 is obtained from dry batteries housed in a drawer, then in the event of irregularity of behaviour which cannot otherwise be traced, do not omit to check that the batteries are correctly connected and that the connections at the back of the drawer are making good contact.

85. If when adjusting the filament rheostats the correct current cannot be obtained, there is probably a high resistance connection somewhere in the filament circuit. This should be located and cleaned up.

86. It should be borne in mind that it is quite impossible, no matter what depth of modulation is used, to obtain good speech *if the aerial current is too large*. When making the grid coupling adjustments to reduce the maximum aerial current to half value as described in para. 68, it is preferable to *err on the side of small aerial current* rather than large.

87. Even on full power there should be little or no sparking at the key contacts. Excessive grid current will cause sparking and if the required power cannot be obtained without sparking at the key, a 1 μ F. condenser in series with a resistance of about 40 ohms should be connected across the key contacts.

88. It is desirable whenever possible to switch on the master-oscillator and to allow the apparatus to attain a steady temperature before commencing to transmit. Generally 10 to 15 minutes will be sufficient and if this procedure is carried out variation of frequency during operation will be almost entirely prevented.

TABLE 1

Range 1. R/T. 6000-4286 kc/s.

Fre- quency kc/s.	Master-Oscillator.			Modu- lator		Amplifier.			Neutralizing condenser degrees.	Aerial.					Volts.
	Tuning condenser.	Grid coupling.		Bias stud.	Anode current mA.	Tuning condenser.	Bias stud.	Anode current mA.		Coil setting (half-coil disconnected).	Series No. 7 condenser.		Coupling degrees.	Current amps.	
		Tap.	Degree								Jars.	Deg.			
6,100	0	2	40	8	77	23	2	160	57	4.37	0.1	10	90	3.0	2,600
5,970	20	2	13	8	77	39	2	135	61	5.53	0.1	10	90	2.6	2,600
5,572	40	2	0	7	95	62.5	3	135	56	3.98	0.15	20	90	3.0	2,600
5,228	60	3	28	8	75	74.5	1	125	52	3.85	0.2	30	56	2.5	2,600
4,955	80	3	9	7	90	96.5	1	150	52	3.95	0.3	50	40	2.6	2,600
4,700	100	3	10	7	87	121.5	1	150	52	5.36	0.3	50	59	2.5	2,600
4,458	120	3	15	7	87	135	1	155	52	4.27	0.4	70	90	3.0	2,600
4,270	140	3	17	7	90	153	1	145	52	3.92	0.95	130	90	3.0	2,600
4,140	160	4	5	7	95	178	7	150	56	5.0	0.95	130	90	3.0	2,600
4,020	180	5	42	7	95	195	1	155	60	5.52	0.95	180	90	3.2	2,600

The links connecting the fixed "packing" condensers should be disconnected. The plugs on the master-oscillator and amplifier tuning coils should be in the sockets coloured blue. The anode feed resistance of the master-oscillator should be 30,000 ohms

TABLE 2
Range 2. C.W. only. 4286-3000 kc/s.

Frequency kc/s.	Master-Oscillator.			Amplifier.			Aerial.		
	Tuning con- denser.	Grid coupling.		Tuning con- denser.	Bias stud.	Anode current mA.	Coupling degrees.	Tuning coil setting.	Current amps.
		Tap.	Degrees.						
4,705	20	4	12	9.4	1	230	25	1.66*	5.0
4,355	40	3	15	27.7	1	250	29	3.24*	5.7
4,070	60	3	31	45	1	260	31	5.0*	5.9
3,840	80	4	3	67	1	260	33	6.93*	5.8
3,630	100	4	13	81	1	256	33	7.76*	5.7
3,440	120	4	17	99.6	1	235	33	2.29	5.3
3,300	140	4	26	117	1	240	33	3.62	5.3
3,170	160	5	5	135	1	280	33	4.82	6.0
3,040	180	5	13	152	1	33	33	6.0	6.2
2,940	200	5	18	168	1	300	33	6.97	6.0

Note :—

(1) Use separate H.T. supply to master-oscillator if possible.

(2) Use the least coupling both from master-oscillator to amplifier and amplifier to aerial that will transfer the necessary power to the aerial. For ranges up to 250 miles, 3 amps. in the above aerial system should be ample to work with appropriate service receiver. * Half coil disconnected.

The links connecting the fixed " packing " condensers should be disconnected. The plus on the master-oscillator and amplifier tuning coils should be in the uncoloured sockets. The anode feed resistance to the master-oscillator valve should be 10,000 ohms.

TABLE 3
Range 3. R/T. I.C.W. C.W. 3000-2500 kc/s.

Frequency kc/s.	Master-Oscillator.			Modulator.		Amplifier.			Neutralizing condenser degrees.	Aerial.			Volts.
	Tuning condenser	Grid coupling.		Bias stud.	Anode current mA.	Tuning condenser.	Bias stud.	Anode current mA.		Coupling degrees.	Tuning coil setting (full coil).	Current amps.	
		Tap.	Degrees.										
3,000	26	5	15	8	86	35	1	210	66	50	1.98	2.4	2,600
2,851	60	5	47	8	82	67	1	205	66	50	3.28	2.5	2,600
2,725	92	5	90	8	90	95	1	175	66	90	4.0	2.2	2,600
2,604	130	6	4	8	75	140	1	250	66	50	6.38	2.5	2,600
2,500	164	6	12	8	80	167	1	220	66	90	7.31	2.4	2,600

The links connecting the fixed " packing " condensers should be connected to the appropriate terminals. The plugs on the master-oscillator and amplifier tuning coils should be in the sockets coloured red. For R/T the master-oscillator anode feed resistance should be 30,000; for C.W. and I.C.W. it should be 10,000 ohms.

For C.W., use separate H.T. supply to the master-oscillator if possible.

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TABLE 4

Settings of transmitter T.70 for rapid frequency change between 4,300 and 5,750 kc/s.

Frequency kc/s.	M/O Con- denser degrees.	Grid coupling coil		AMP. tuning con- denser degrees.	Aerial coupling con- denser degrees.	Neutra- lizing con- denser degrees.	Aerial tuning coil		Series aerial con- denser degrees.
		Tap.	Degrees.				Turns.	Degrees.	
4,300	180	3	27	163	90	47	8	0	250
5,000	107	3	25	92	90	40	5	0	150
5,550	69	3	37	60	90	44	3	50	150
5,750	53	3	17	46	90	44	1	86	150

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7755	Transmitter T.70 :— Principal components :—		Without valves, neon lamp and batteries.
	Ammeter,		
10A/7782	Moving-iron, 0-10	3	
10A/7783	Thermo, 0-8	1	
10A/3178	Thermo, 0-12	2	
	Choke,		
10A/7786	H/F, type 9	2	
10A/7512	L/F, type C	1	
10A/7756	Clip, tuning coil	10	
	Condenser,		
10A/7759	Type 104	2	110-360 μ F (variable).
10A/7760	Type 105	2	.00025 μ F bank of 8 units.
10A/7761	Type 106	1	40 μ F neutralizer.
10A/7762	Type 107	1	.0001 μ F
10A/7763	Type 108	3	.001 μ F.
10A/7764	Type 109	2	.002 μ F.
10A/7765	Type 110	7	.01 μ F.
10A/7895	Type 118	1	0.5 μ F.
10A/8098	Type 146	4	1.0 μ F meter shunts.
10A/10920	Type 428	4	
10A/1871	Insulator, type 5	1	Aerial.
	Milliammeter,		
10A/7177	0-5	1	
10A/7123	0-30, type A	1	
10A/1504	0-100, type A	1	
10A/3190	0-250	2	
10A/3092	0-500, type A	1	
10A/7757	Motor, interrupter, 20-volt	1	
	Resistance,		
10A/2312	Type 26	1	2 M Ω .
10A/7295	Type 40	1	500,000 ohms, variable.
10A/7766	Type 82	8	40 ohms, wire-wound.
10A/7767	Type 83	3	4 ohms, variable.
10A/7768	Type 84	1	60,000 ohms.
10A/7769	Type 95	2	5 M Ω .
10A/7770	Type 86	1	10,000 ohms for C.W. and I.C.W.
10A/7771	Type 87	1	50,000 ohms.
10A/7772	Type 88	1	50,000 ohms.
10A/7773	Type 89	1	7 ohms.
10A/8141	Type 125	1	30,000 ohms for R/T alternative to 10A/7770.
	Switch,		
10A/7774	Type 56	1	14-contact, grid-bias.
10A/7775	Type 57	1	16-contact, grid-bias.
10A/7776	Type 58	1	2-position, line switch.
10A/7777	Type 59	1	R/T, C.W., I.C.W. switch.
10A/7778	Type 60	1	2-position, H.T. switch.
10A/7779	Type 61	1	2-position, L.T. switch.
10A/7780	Type 62	1	H.T. change-over switch.
10A/7781	Type 63	1	Neutralizer.

SECTION 1, CHAPTER 1

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter, T. 70— <i>continued</i>		
	Principal components— <i>continued</i>		
	Transformer, microphone,		
10A/7785	Type E	1	
10A/7322	Terminal	1	Counterpoise.
10A/7784	Voltmeter, moving coil	1	0-3500.
	Accessories,		
5A/1338	Battery, dry, 15-volt	30	For battery grid-bias.
10A/7474	Lamp, indicating, neon, No. 1	1	
	Valves,		
10A/5203	Type V.T.4B.	1	Amplifier.
10A/1651	Type V.T.5B	1	Master-oscillator.
10A/7787	Type D.E.T.3	1	Modulator.
10A/1651	Type V.T.25	1	Sub-modulator.
10A/7104	Interrupter motor, brushes	2	
10A/7758	Interrupter disc, 10-segment	1	
10A/2951	Condenser, type 7 (1 jar)	1	Aerial, series, if required.
10A/9812	Panel contact, grid-bias unit	1	Alternative to battery grid-bias.
10A/9804	Unit, grid-bias	1	

FOR OFFICIAL USE ONLY

December, 1938

AIR PUBLICATION 1186

Volume I

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TRANSMITTER T.77

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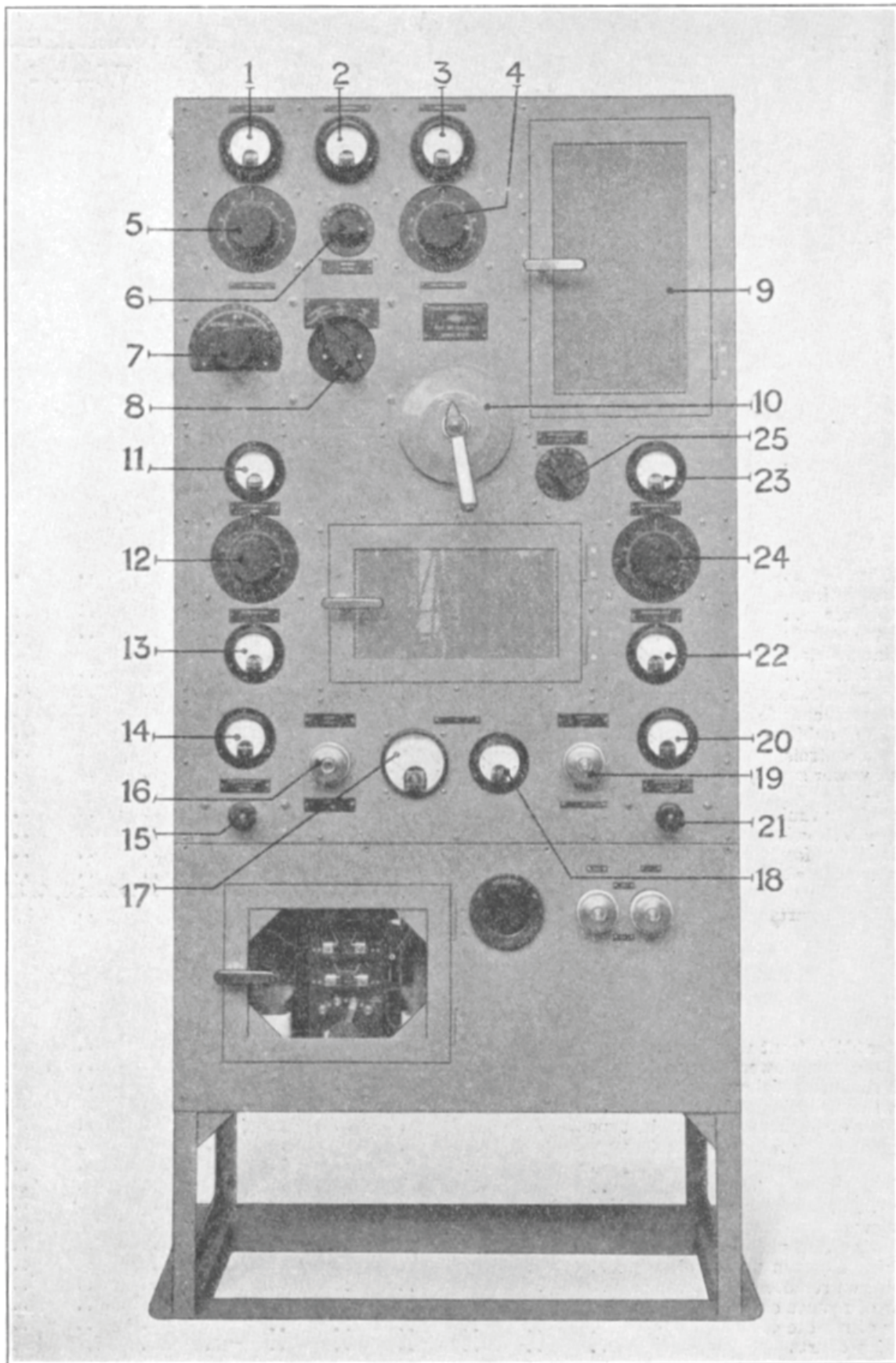


FIG. 1. Transmitter T.77, front view.

TRANSMITTER T.77

(Stores Ref. 10A/8151)

INTRODUCTION

1. The transmitter T.77 is a master-oscillator controlled ground station transmitter designed for continuous wave transmission on the frequency bands 143 to 400 kc/s. and 1,500 to 2,256 kc/s. A socket is provided on the transmitter which enables a modulating amplifier to be used when R/T or M.C.W. is required.

2. The transmitter is so designed that it may be conveniently adapted for A.C. or D.C. supply. When used for D.C. the rectifier portion (panel, rectifying, type A, Stores Ref. 10A/8068) is removed and a dummy panel fitted in its place. The smoothing unit which is incorporated in the transmitter is not removed with the rectifier but remains in circuit for D.C. operation. The transmitter is adapted to be operated either directly or by remote control.

3. The transmitter comprises a master-oscillator circuit which controls, through an intermediate amplifier or buffer circuit, a power amplifier or output circuit. The aerial circuit is capacitance-coupled to the amplifier. The buffer circuit serves not only as an amplifying circuit but also as an isolating stage which, by preventing "feedback" between the output circuit and the M/O, serves to stabilize the frequency. This buffer circuit renders neutralization in the output circuit unnecessary.

4. In order to cover the two frequency bands without change of coils, etc., variometer tuning is employed, the windings of the variometers being connected in series for the lower frequencies and in parallel for the higher frequencies. The M/O and intermediate stage variometers are, on the lower frequencies shunted by variable condensers which are mechanically coupled to and simultaneously operated by the variometer spindles. Fixed capacitance coupling is employed between the M/O and the intermediate amplifier stage and between the latter and the output stage. The aerial coupling is effected by a variable condenser. Automatic grid-bias is provided for the valves in the intermediate and power amplifier circuits. Keying is effected by means of an electro-magnetically operated switch which makes and breaks the H.T. negative and grid-filament circuits of all three stages. A combined electro-magnetically operated "Send-Receive" and "H.T. on and off" switch is incorporated in the transmitter. By means of this switch the aerial is disconnected from the transmitter and connected to a receiver, the transmitter H.T. circuit being opened simultaneously.

5. The rectifying portion comprises two gas-filled rectifying valves and the necessary transformers and electro-magnetic switches. The rectifying panel is fully described in another chapter of this publication.

GENERAL DESCRIPTION**Transmitter**

6. A theoretical circuit diagram of the transmitter is given in fig. 4. V is the master-oscillator valve, V_1 the intermediate amplifier valve (actually two valves in parallel) and V_2 is the power amplifier or output valve. The oscillatory circuit of the master-oscillator valve V, is of the Hartley type and consists of a variable inductance L across which is connected a variable condenser C. The variable inductance L is a variometer and the two windings are connected in series for the lower frequency band and in parallel for the higher frequency band. A filament centre-connection unit consisting of two condensers C_1 and C_2 and two resistances

SECTION 1, CHAPTER 2

R and R_1 is connected across the filament leads of V . The centre-point of the unit is connected to earth *via* the keying relay RL . Two further resistances R_2 and R_3 are included as filament resistances in the M/O filament circuit. R_4 is the grid-leak resistance and C_4 the grid coupling condenser. C_5 is the mains condenser.

7. The H.T. fed to the M/O oscillatory circuit is taken *via* the anode resistance R_6 and R/F choke L_1 through the range change switch to the centre-point of L . A milliammeter M , shunted by the condenser C_6 , is in series with the anode resistance and choke. When working on the higher frequency band, instead of the variable condenser C , the inductance L_2 and fixed condenser C_9 are connected in parallel with the inductance L . The H.T. feed is then made to the tapping point of L_2 , instead of the centre-point of the variometer. C_8 and C_7 are the coupling condensers between the M/O and the intermediate stage for the lower and higher frequencies respectively.

8. The filaments of the two intermediate amplifier valves V_1 have four resistances R_8 , R_7 , R_9 and R_{10} included in the filament circuits, while the variable resistance R_{10} provides a means of controlling the filament voltage of both the M/O and intermediate stage valves. The variometer L_3 , in conjunction with the variable condenser C_{10} , forms the tuned oscillatory circuit for V_1 . The windings of L_3 can be connected in series for the lower frequency band and in parallel for the higher frequency band. The H.T. is fed through an anode resistance R_{11} and an R/F choke L_4 . A milliammeter M_1 shunted by the condenser C_{11} is also included in the H.T. circuit. Coupling between the intermediate stage and the power output stage is effected by the condenser C_{12} for the higher frequencies, and C_{13} for the lower frequencies. When working on the higher frequency band the inductance L_5 and fixed condenser C_{12} are connected in parallel across the variometer in place of the variable condenser C_{10} .

9. Grid-bias for the valves V_1 is obtained from the resistances R_{12} which are connected between the grid of the valve and H.T.—. A movable arm selects a suitable tapping on the resistance. The R/F choke L_6 is connected in the grid circuit of the valves V_1 . For R/T and M.C.W. a modulating amplifier is introduced into the grid circuit by means of the combined socket and switch S .

10. The power amplifying valve V_2 is provided with a filament centre-connection unit consisting of the resistances R_{13} and R_{14} and the condensers C_{15} and C_{16} . The centre-point of this unit is connected to earth *via* the keying relay RL . The filament voltage is controlled by means of the variable resistance R_{15} . Grid bias for the valve V_2 is obtained from the tapped resistance R_{13} , while the choke L_7 is included in the grid circuit of the valve. The R/F choke L_8 and milliammeter M_2 , the latter shunted by the condenser C_{18} , are included in the H.T. circuit of V_2 .

11. The windings of the variometer L_9 are connected in series for the lower frequencies and in parallel for the higher frequencies. The condenser C_{19} is connected across the variometer for lower frequencies, and the condenser C_{20} and inductance L_{10} in parallel, are connected across the variometer windings for the higher frequencies.

12. The pulse coil L_{11} is provided with several tapping points brought out to a terminal board. A flexible lead from the anode of V_2 terminates in a socket which can be engaged with one of the plugs on the pulse coil. Similarly the two ends of the oscillatory circuit of V_2 can be connected to any tapping point on L_{11} . In the lower frequency position the lower portion of L_{11} is used and in the higher frequency position, the upper portion of L_{11} is brought into circuit.

13. Variable capacitance coupling is employed between the output amplifier and the aerial circuit, C_{21} being used for this purpose. The aerial tuning inductance L_{12} is a variometer, the windings of which are connected in series for the low frequency band and in parallel for the high frequency band. In addition the aerial inductance L_{13} is connected across the variometer windings for the higher frequencies. C_{22} is the mains condenser. The aerial loading coil L_{14} is constructed in two portions and a three position switch S_1 connects the aerial directly to L_{12} in position 1,

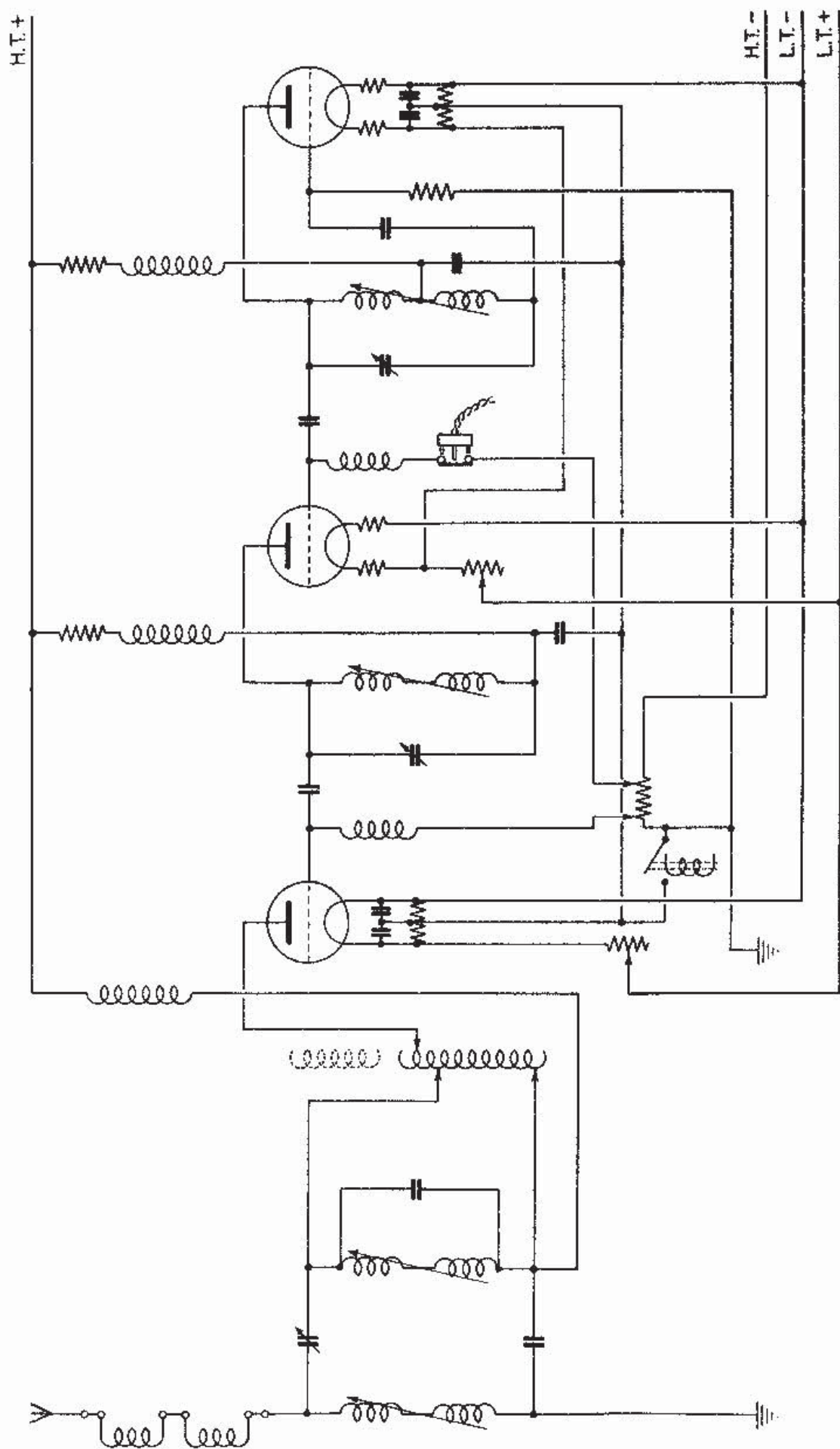


FIG. 2. SIMPLIFIED DIAGRAM (LOWER FREQUENCIES)

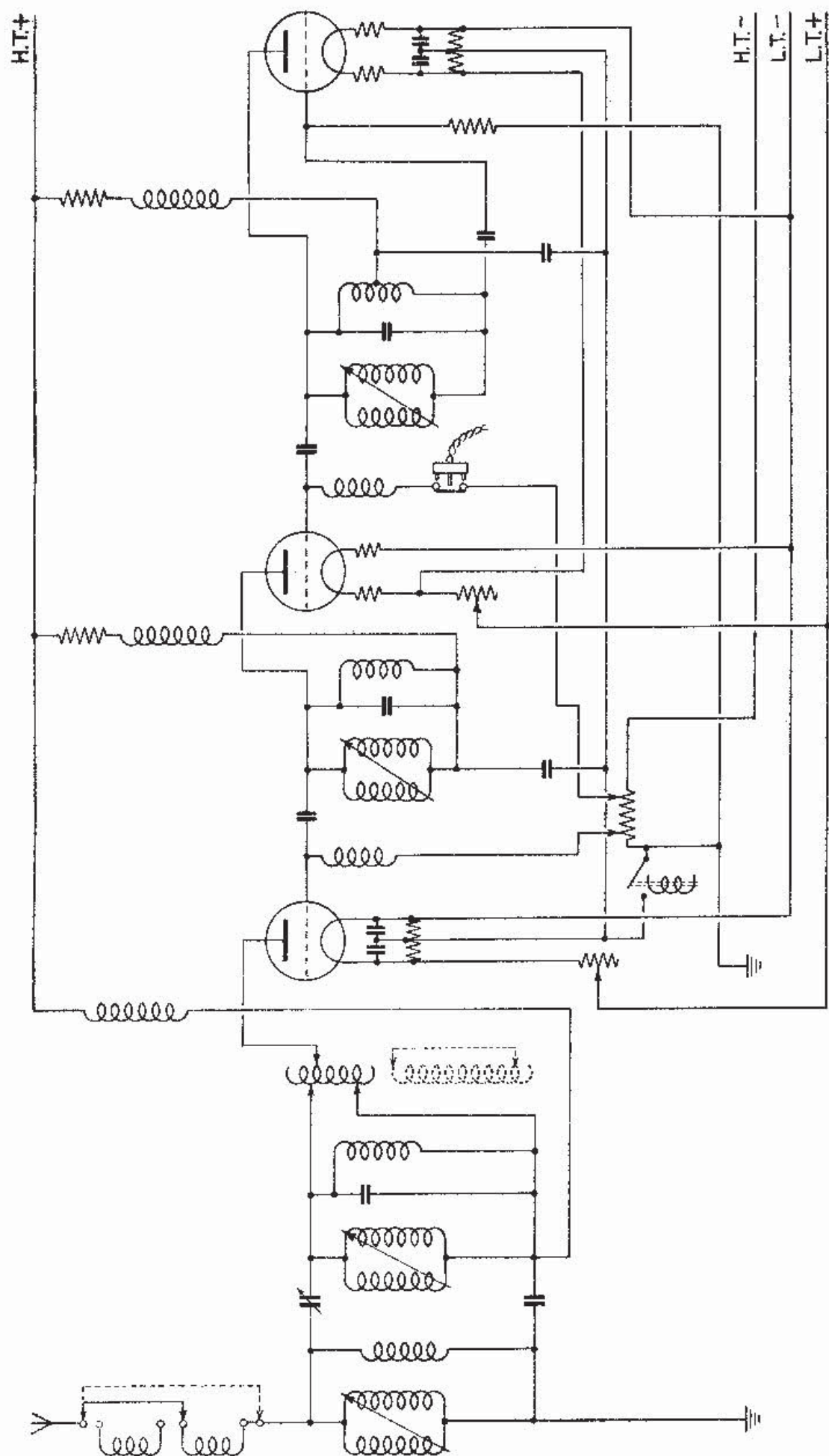


FIG. 3. SIMPLIFIED DIAGRAM (HIGHER FREQUENCIES)

SECTION 1. CHAPTER 2.

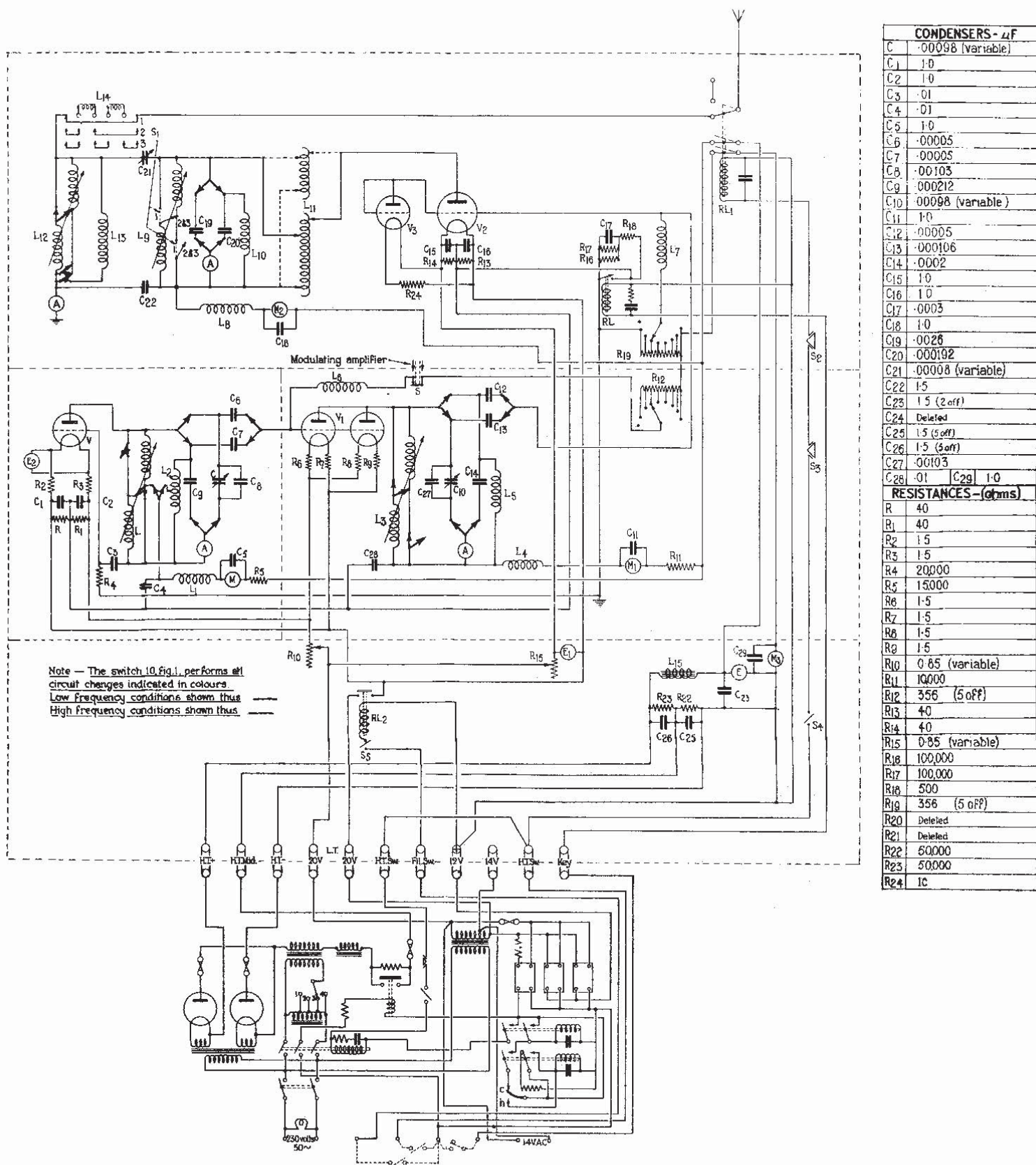


FIG. 4. THEORETICAL CIRCUIT DIAGRAM

connects a portion of the coil in the aerial circuit in position 2, and connects the whole coil in circuit in position 3. The switch S_1 also performs the connections (series and parallel) on the power amplifier variometer L_9 . In position 1, the windings are connected in parallel, and in positions 2 and 3 the two windings are connected in series. The relay RL_1 makes and breaks the transmitter H.T. circuit, and also transfers the aerial from the transmit to the receive position.

14. The solenoid for the relay RL_1 and the solenoid for the keying relay RL are both operated from the same source. If A.C. is being used, the solenoids are energized from the rectifiers. If D.C. is used, then a 12-volt battery supplies the power for the solenoids. In circuit with the solenoid for RL_1 are the gate switches S_2 and S_3 and the tumbler switch S_4 . This latter switch is represented by (16, fig. 1). The keying relay solenoid is operated by the key. Hence it will be seen that once the switch S_4 is closed, the H.T. is switched on and the aerial is connected in the transmit position. Operation of the key now results in the H.T. negative and filament circuits of the valves in all three stages being interrupted.

15. On closing the tumbler switch S_5 , the relay RL_2 is energized and the filament circuits of all three stages are made. The switch (10, fig. 1), which changes the connections of the variometer coils L_1 , L_2 , and L_{12} , is represented diagrammatically in this figure by red lines and is shown in the lower frequency position. Movement of the switch handle effects all the changes from red lines to green lines establishing the higher frequency circuits.

16. The input milliammeter M_3 is shunted by the condenser C_{29} and is in the H.T. + feed. The voltmeter E is across the H.T. + and H.T. - lines, while the iron-cored choke L_{16} is in the H.T. + line. The condensers C_{23} , C_{24} , C_{25} and C_{26} , together with the resistances R_{20} , R_{21} , R_{22} and R_{23} form the smoothing unit which is used on either A.C. or D.C. The voltmeter E_1 indicates the filament volts on the power amplifier valve, and E_2 indicates the filament volts for the M/O, and intermediate circuits.

17. Owing to the possibility of secondary grid emission with certain valves used in the power amplifying stage, a three-electrode valve V_3 connected as a diode has been introduced into the grid-filament circuit of the power amplifier to provide a permanent bias on the grid of the valve. To enable this to be fitted, a grid adaptor (Stores Ref. 10A/8297) consisting of a valve-holder and filament resistance is supplied. The adaptor is fitted behind the detachable panel which carries the power amplifying valve V.T.4B. Of the three lugs on the adaptor, the two filament lugs are connected to the filament terminals, and the remaining lug is connected to the grid terminal of the V.T. 4B. valve. The valve used in the adaptor is a V.T. 13C.

Remote controls

18. The transmitter may be used in conjunction with Ground Station Remote Controls type 2 or 4 (for C.W.) or Ground Station Remote Controls, type 3 (for C.W., M.C.W., and R/T). The manner in which the remote controls, type 2, are connected up to the transmitter is illustrated in fig. 5. The apparatus at the operating end comprises a microphone, microphone transformer, switch type 44, repeating coil, key and a 24-volt battery. The apparatus is grouped on a table and wired up as shown on the left of the figure. The ends of the secondary winding of the repeating coil at the operating end are connected through a distribution box, a junction box and through a pair of land lines to similar apparatus at the transmitting end. The pair of land lines carries the operating current for the FIL. and H.T. relays incorporated on the remote controls, type 2, at the transmitting end.

19. The terminal strip on the remote control unit is connected to the terminal strip at the bottom of the transmitter by short leads in the manner illustrated. The 14 volts A.C. required for operating the keying relay is obtained from the rectifier unit incorporated in the transmitter by connecting across the fourth and ninth terminals, reading from the left.

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20. The transmitter is capable of being operated from either A.C. or D.C. mains and both methods are shown. The A.C. method is the normal one, but when D.C. mains are used an additional sounder relay is provided on the switch panel. The windings of this relay are connected in parallel with the windings of the filament relay on the remote control unit.

21. When the switch type 44 at the operating end is placed in the "generator running" position, the windings of the FIL. relay on the remote control unit are connected between the positive side of the battery and earth. Since these windings are connected in parallel with the windings of the relay on the switch panel, this relay also becomes energized. The tongue and mark terminals are connected to a relay which closes the D.C. mains circuit, and the motor-alternator may then be started up.

22. The schematic diagram shown in fig. 6 is very similar to fig. 5 except that remote controls, type 3, are used. The lines A and B are connected to the terminal strip at the bottom of the remote control unit. The various connections from FIL.SW., H.T., and KEY are taken to the transmitter as before. The terminals P.O. LINES are for use in connection with remote R/T modulation from a special line. The amplifier A.1104 forms part of remote controls, type 3, and provides the modulating voltage for M.C.W. and R/T transmission. A screened cable terminating at each end in a plug is used for connecting the output of the amplifier to the transmitter. Since 230 volts A.C. is required for A.1104, a pair of leads is taken from the 230 volt terminals on the T.77 to the amplifier. The 14 volts A.C. required for the rectifier in the circuit of the keying relay on remote controls, type 3, is obtained from the rectifier unit incorporated in the transmitter.

23. Provision is again made for operating the transmitter from either A.C. or D.C. mains, the system employed being the same as described previously. The transmitter may be operated or remotely controlled by type 4 remote controls, but as this type is somewhat similar to remote controls, type 2, no mention is made of it here. A full description of remote controls will be found elsewhere in this publication.

CONSTRUCTIONAL DETAILS

Transmitter

24. The transmitter T.77, a front view of which is given in fig. 1, and three bench wiring diagrams in figs. 8, 11 and 12, is built up of aluminium alloy sheets mounted on a duralumin frame work. The overall dimensions are about 5 ft. 6 in. high, by 2 ft. 6 in. wide, by 18 in. deep, and the approximate weight is $4\frac{1}{2}$ cwt. The various components are housed in four compartments or cubicles, and access is given to the various valves by means of three doors. The upper or first cubicle contains the output valve and associated equipment. The second cubicle contains the master-oscillator and the intermediate amplifier components; the M/O is on the left and suitably screened from the amplifiers which are on the right. The third cubicle houses the smoothing units and the fourth cubicle houses the rectifier unit.

25. The three doors provided on the front of the transmitter are each equipped with a safety switch which operates an electro-magnetic switch to break the power supply circuit. The doors in the first and second cubicles which give access to the power output valve and the M/O valve respectively are provided with perforated panels to allow for ventilation, but the door in the rectifier unit is provided with a glass panel. The rear and side portions of the transmitter are built up of perforated material so that adequate ventilation is available.

26. Referring to fig. 1, it will be seen that a number of instruments and control handles are mounted on the front of the transmitter. The 0 to 6 amp. aerial ammeter (1) can be seen in the top left hand corner and next to it is the power amplifier anode circuit milliammeter (2) reading 0 to 300 mA. The 0 to 12 amp. ammeter (3) is in the closed circuit of the power amplifier,

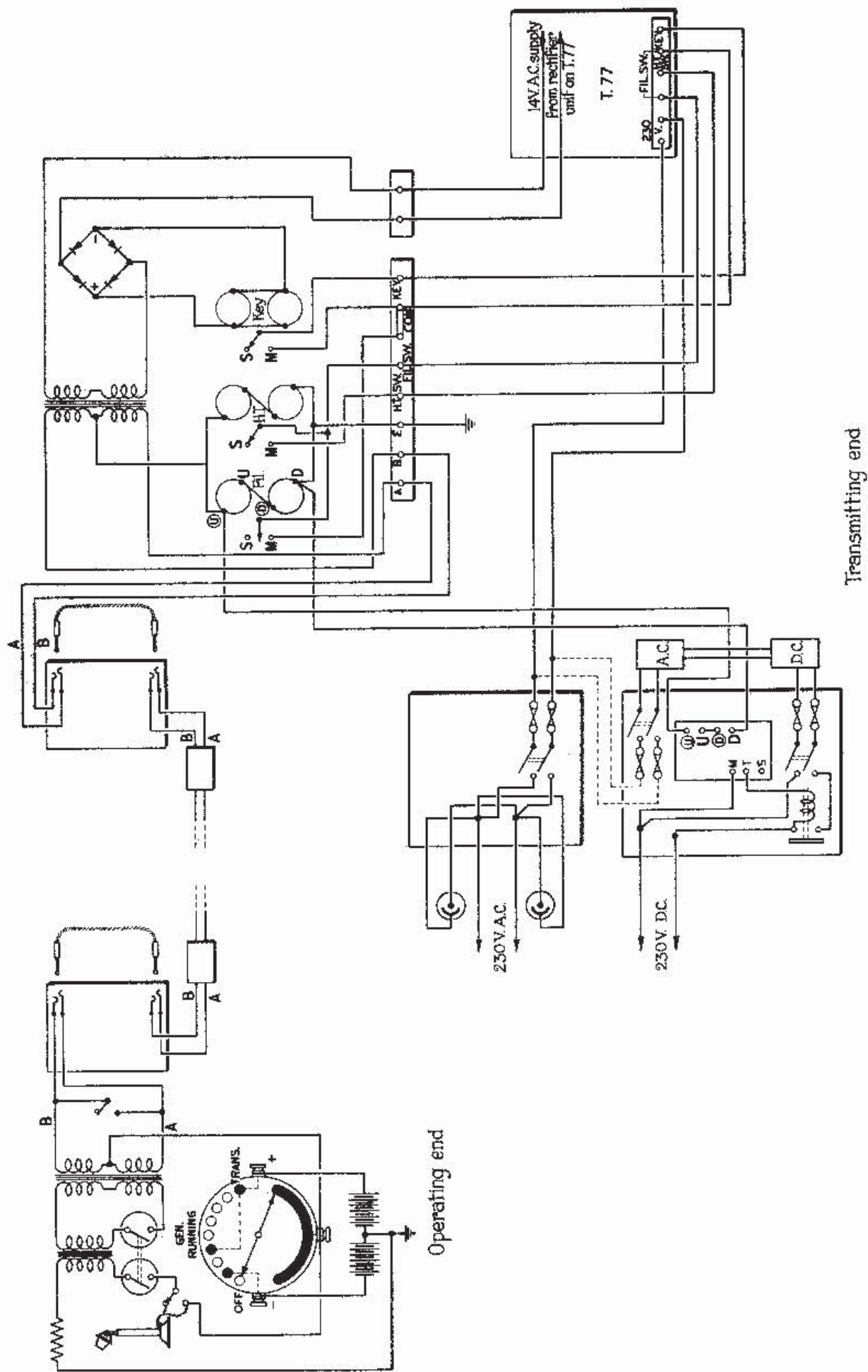


FIG. 5. T. 77 AS OPERATED BY REMOTE CONTROLS, TYPE 2

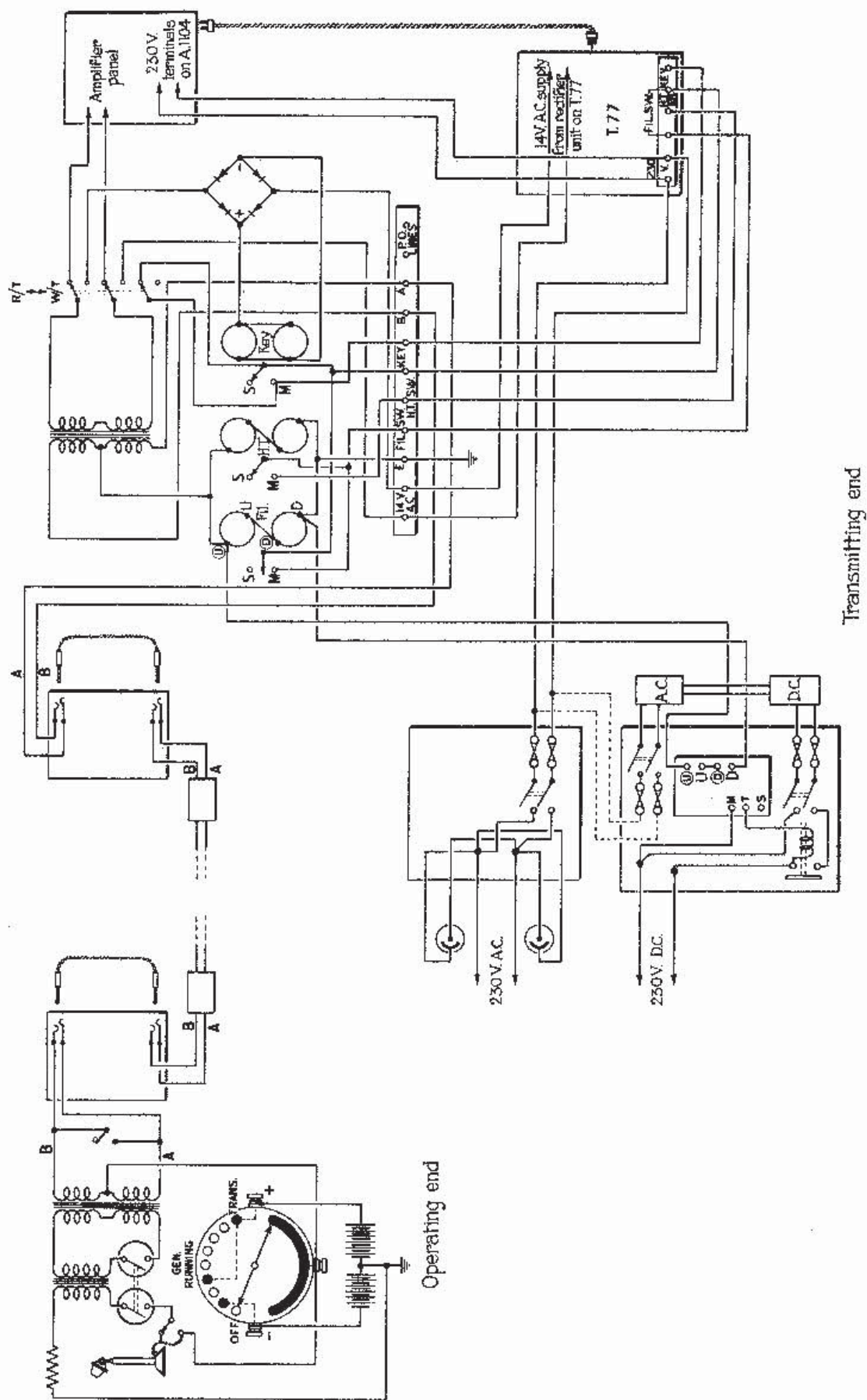


FIG. 6. T. 77 AS OPERATED BY REMOTE CONTROLS, TYPE 3

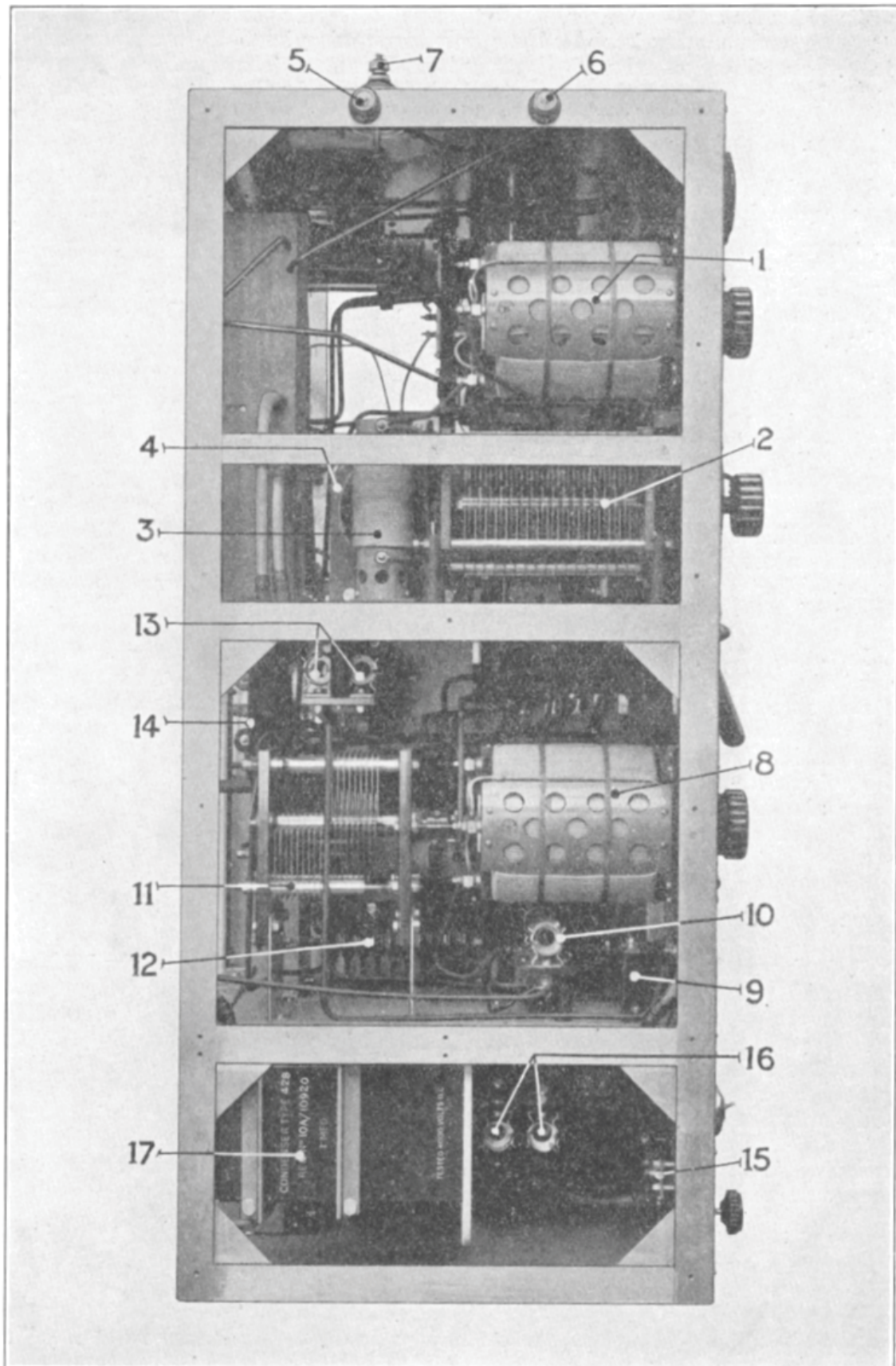


FIG. 7. Interior view of transmitter, left-hand side.

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while the control knob (4) underneath it is the power amplifier tuning control. The aerial tuning control (5) is under the aerial ammeter, and to the right of it is the power amplifier grid-bias control knob (6). The aerial tuning knob and the amplifier tuning knob are each provided with an indicator and a scale engraved with one hundred divisions. The number of complete turns made by the knob can be seen through a small window directly above the knob. The amplifier grid-bias has a scale engraved from 0 to 16, and an indicating line on the knob registers with one of these figures.

27. The aerial coupling control (7) is in the bottom left-hand corner of the first cubicle. It has a scale engraved from 0 to 120°. To the right is the aerial loading switch (8). It has three positions, 1, 2 and 3. The first position is engraved 260 to 400 kc/s and 1,500 to 2,256 kc/s, the second position is engraved 160 to 260 kc/s and the third position is engraved 143 to 160 kc/s. The hinged door (9) is provided in order to give access to the amplifier valve. The range change switch (10) in the centre of the transmitter has two positions engraved 143 to 400 kc/s and 1,500 to 2,256 kc/s.

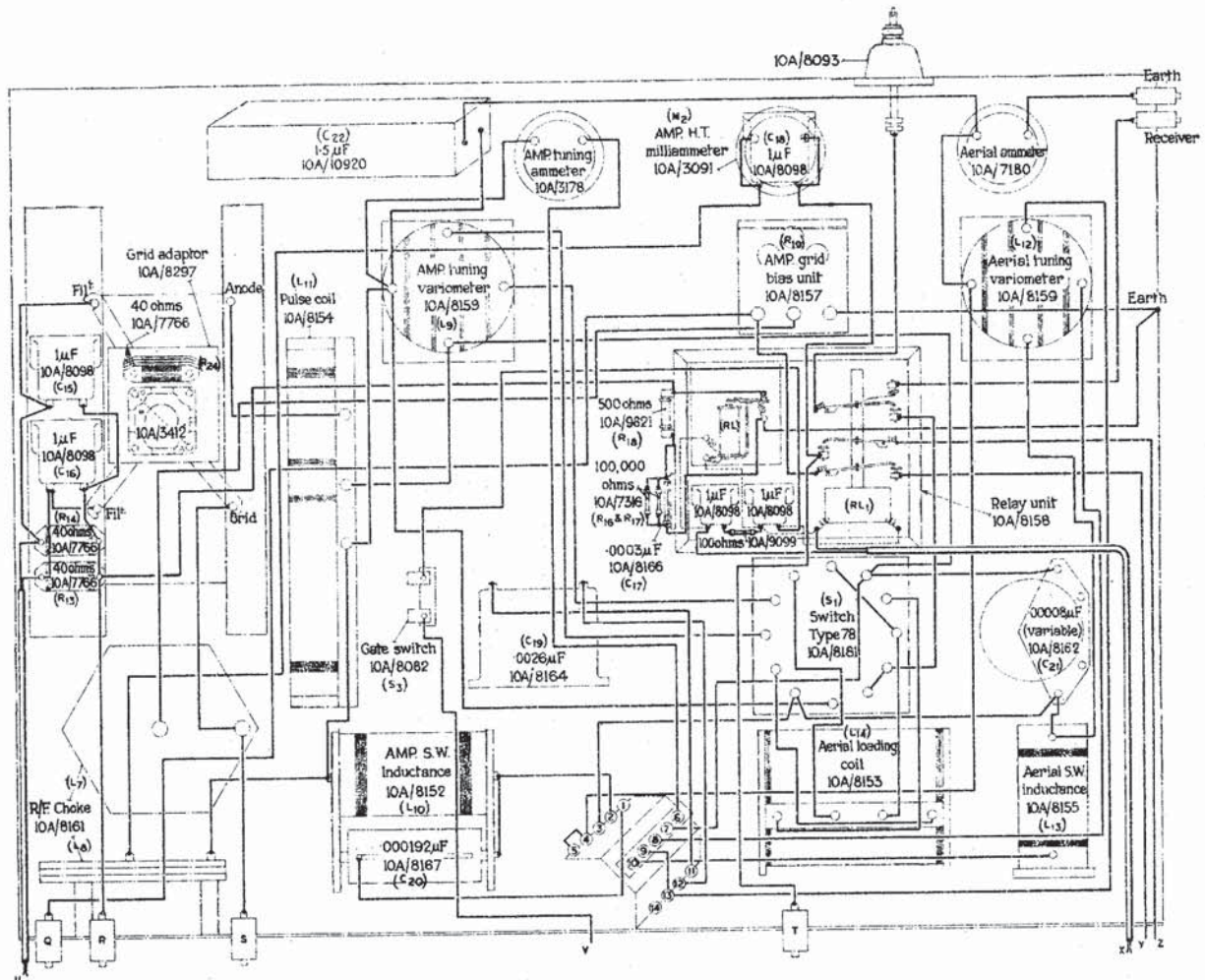
28. The 0 to 4 amps. master-oscillator oscillatory circuit ammeter (11) is in the top left-hand corner of the second cubicle, while just below it is the M/O tuning control (12). It has a scale engraved with one hundred divisions and an indicating window. The master-oscillator H.T. milliammeter (13), reading 0 to 100 mA, is below the tuning control, and below this is the 0 to 15 volts filament voltmeter (14) and control knob (15) for the M/O and intermediate circuit valve filaments. The send-receive switch (16) breaks the H.T. supply in the up or "receive" position and makes the H.T. in the down or "send" position. The 0 to 3,500 volt D.C. voltmeter (17) and the milliammeter (18) reading 0 to 500 mA. register the H.T. volts and the total input respectively. The tumbler switch (19) breaks the L.T. supply to the transmitter valve filaments in the up or off position and makes it in the down or on position.

29. In the right-hand bottom corner can be seen the 0 to 20 volt power amplifier filament voltmeter (20) and rheostat control knob (21). Above the filament voltmeter is the 0 to 200 mA. intermediate amplifier anode circuit milliammeter (22). The 0 to 4 amps. ammeter (23) and control knob (24) are in the tuned circuit of the intermediate amplifier while the grid-bias control (25) is on the left of the ammeter (23). It is engraved from 0 to 16 and a line engraved on the control handle indicates the bias setting. The door in the centre of the cubicle gives access to the M/O and intermediate amplifier valves. When the door is opened a contact switch breaks the H.T. circuit. The bottom cubicle houses all the rectifying equipment and is described elsewhere.

First cubicle

30. Referring to fig. 7 which is a view of the transmitter from the left-hand side, excluding the rectifier unit, some of the aerial and power amplifier components can be seen in the first cubicle. The aerial tuning variometer (1) can be seen on the right and below it the aerial coupling condenser (2) which is represented by C_{21} in the theoretical circuit diagram (fig. 4). The aerial inductance (3) can be seen to the left of the coupling condenser, while the aerial loading coil (4) can just be seen behind the aerial inductance. The wooden container on the left houses the aerial relay and the keying relay. The two terminals (5) and (6) seen at the top of the transmitter are engraved EARTH and RECEIVER respectively, whilst behind them is the aerial lead-in (7). The terminal (5) is connected to a suitable earth and the terminal (6) is provided to allow a receiver to be connected up in certain circumstances.

31. Fig. 9 is a rear view of the transmitter with the panels removed. In the top cubicle can be seen the relay panel. The relay (1) on the right is provided with three sets of contacts. The bottom set opens or closes the H.T. — circuits of the valves, the middle set opens or closes the H.T. + circuits and the top set changes over the aerial from the "transmit" to the "receive" position and *vice versa*. The relay (2) is in the key circuit and is arranged to "key" the H.T.



NOTE (a) Annotations in parenthesis, for example (C₁₉), refer to the corresponding annotations in Fig. 4

(b) Wires U, V, X, Y and Z, and terminals Q, R, S and T are also illustrated and similarly annotated in Fig. 12

FIG. 8. BENCH WIRING DIAGRAM (FIRST CUBICLE)

negative and filament circuits of all three stages. Future contracts for the T.77 will have the relay type 31 instead of the relay type N as shown in the illustration. The two $1\mu\text{F}$ condensers (3) and the 100-ohm resistance (4) are part of the relay unit.

32. The 500-ohm resistance (5) and $.0003\mu\text{F}$ condenser (6) are connected in series across the contacts of the keying relay. The amplifier lower frequency inductance (7) has a bank of six condensers mounted on its frame. Two of these condensers (8) can be seen in the centre foreground. Behind the inductance can be seen the pulse coil (9), which consists of two separate coils wound on the same former. Each coil is provided with several tapping points which are brought out to a numbered terminal board. The coil is connected in circuit by means of flexible leads terminating in sockets. It is represented by L_{11} in the theoretical circuit diagram (fig. 4). The R/F choke (10) on the left of the transmitter is connected in the grid circuit of the power amplifier valve, and the R/F choke (11), which is similar to (10), is connected in the power amplifier H.T. feed. The two resistances (12) seen on the left-hand side have a value of 40 ohms each and are connected in series across the power amplifier filament leads.

33. Referring to fig. 10 which is a view of the transmitter from the right-hand side, the power amplifier valve (1) can be seen on the left. Mounted on the valve-holder support are two condensers (2). They have a value of $1\mu\text{F}$ each and are connected in series across the valve filament leads. The grid adaptor valve (3) can be seen near the two condensers. The $1.5\mu\text{F}$ condenser (4) strapped to the top of the cubicle, forms the H.T. blocking condenser represented by C_{22} in the theoretical circuit diagram.

Second cubicle

34. The components associated with the M/O and the intermediate amplifier are housed in the second cubicle the interior of which can be seen in figs. 7, 9, and 10. The M/O components are clearly indicated in fig. 7 which is a view of the left-hand side of the transmitter. On the right is the M/O tuning variometer (8). The two windings of the coil are connected in series for low frequencies and in parallel for high frequencies. The range-change switch (10, fig. 1) effects the change of connections. The $1\mu\text{F}$ condenser (9) in the bottom right-hand corner is connected across the M/O, H.T. milliammeter. The resistance (10) to the left of the condenser has a value of 20,000 ohms and is the grid-leak resistance for the M/O valve. The variable condenser (11) seen on the left is the tuning condenser, the movable vanes being mechanically coupled to the same spindle by which the variometer (8) is actuated. Behind the condenser may be seen the M/O inductance (L_3 , fig. 4). Carried on the frame of this inductance is a bank of ten condensers (12) which are connected across the variable tuning condenser and are represented by C_8 in fig. 4. The two 30,000-ohm resistances (13) connected in parallel form the 15,000-ohm anode resistance for the M/O valve. The R/F choke (14) which can just be seen in the background is represented by L_1 in fig. 4.

35. Both the M/O and the intermediate stage components can be seen in fig. 9. The M/O components are on the right and the intermediate stage components are on the left. The R/F choke (13) has already been referred to in the previous paragraph. To the left of this is the R/F choke (14) in the intermediate amplifier H.T. circuit. The condenser (15) has a value of $.00005\mu\text{F}$ and is the intermediate amplifier high frequency band coupling condenser, while the condenser (16) below it is the low frequency band coupling condenser and has a value of $.000106\mu\text{F}$. The variable condenser (17), of which only the rear can be seen, is the tuning condenser C_{10} , fig. 4.

36. The components seen in the middle cubicle of fig. 10, which is a view of the transmitter from the right-hand side, are associated with the intermediate amplifier stage. The tuning condenser (5) is mechanically coupled to the variometer (6). As in the case of the M/O, this variometer also has its windings connected in series for the low frequency band and in parallel

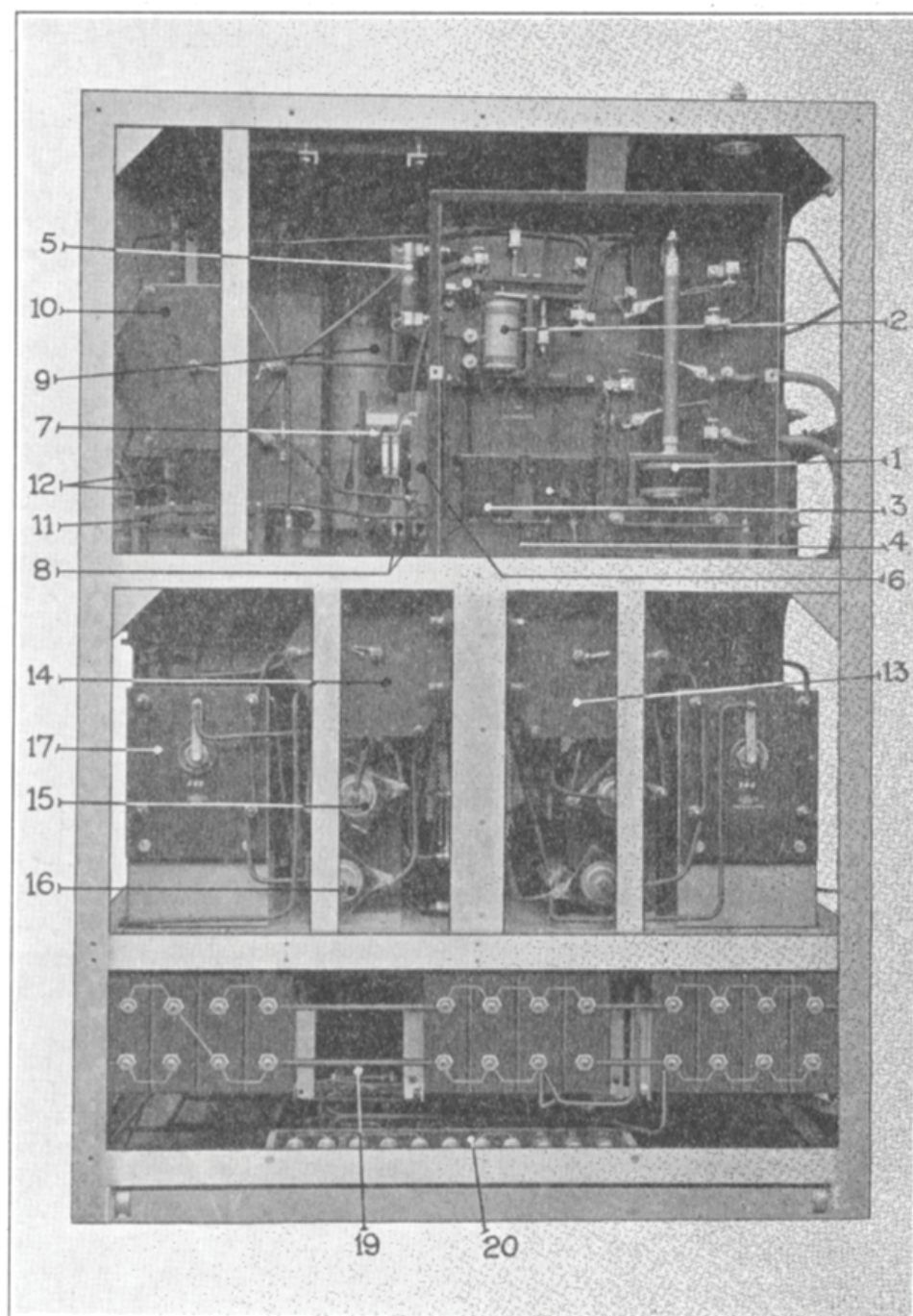


FIG. 9. Rear view of transmitter, without rectifier unit.

for the high frequency band. The modulating amplifier socket (7) is mounted above the variometer. The two 20,000-ohm resistances (8) in the top right-hand corner are connected in parallel to form the 10,000-ohm anode resistance R_{11} , fig. 4. One of the amplifier valve-holders (9) may be seen in the bottom left-hand corner. The $1\mu\text{F}$ condenser (10) in the left-hand corner is connected across the terminals of the H.T. milliammeter. The bank of ten condensers (11) below the variable condenser (5) are mounted in the frame of the tapped inductance coil (12), just showing behind the variable condenser. The bank of condensers (11) are represented by C_{14} in the theoretical circuit diagram; they have a total value of $.00103\mu\text{F}$ and are connected across the variable condenser.

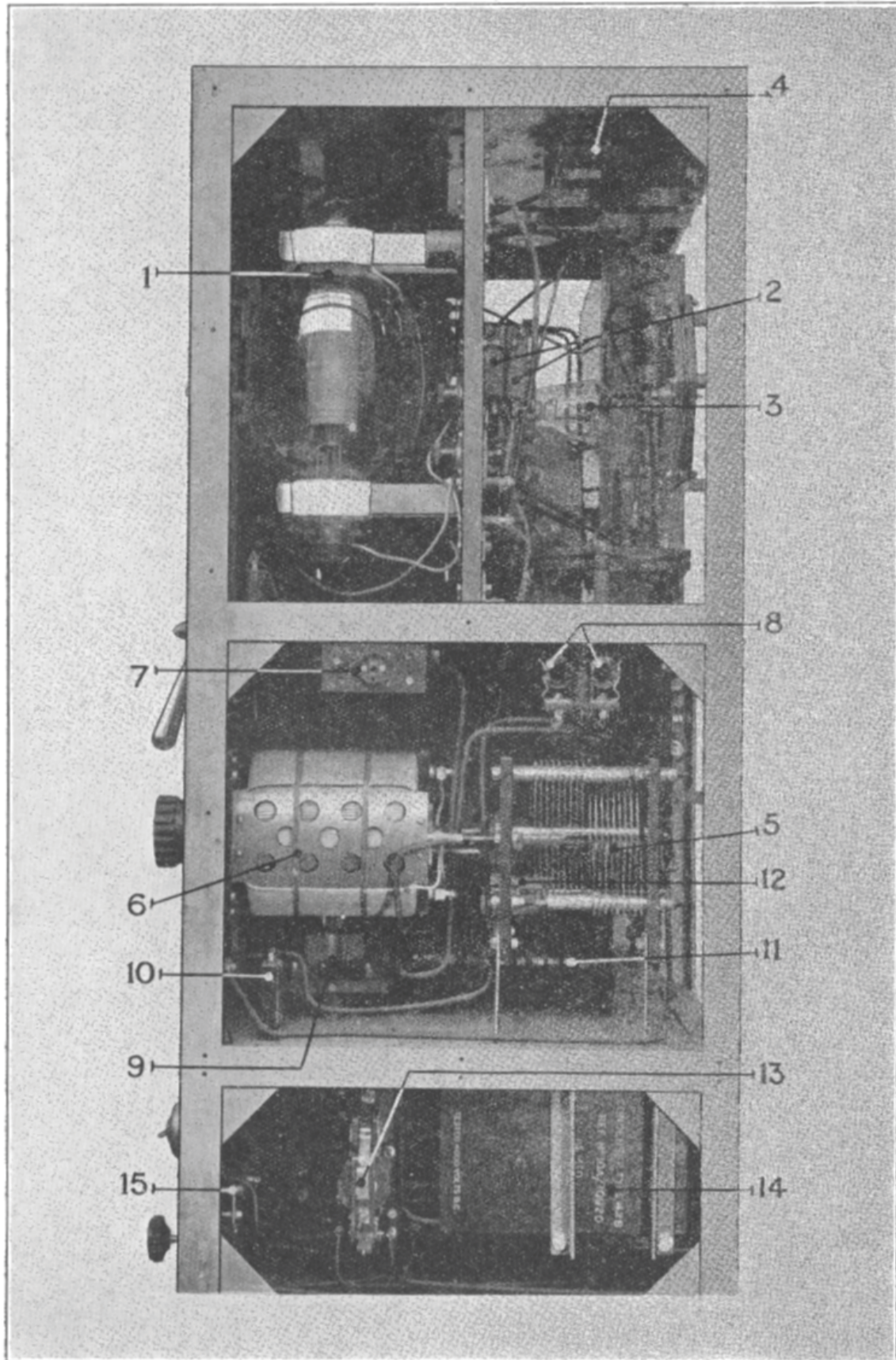
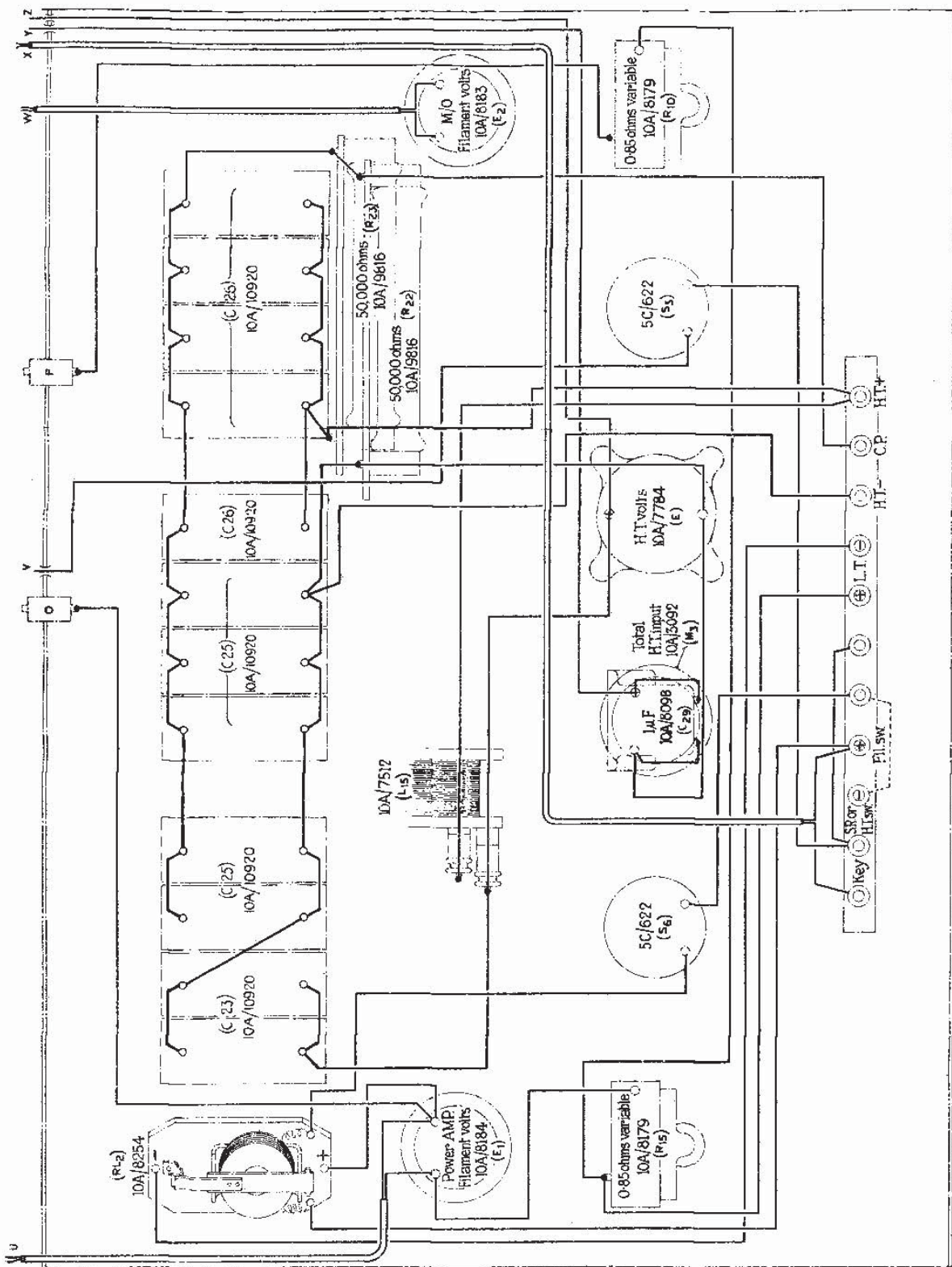


FIG. 10. Interior view of transmitter, right-hand side.

(c) Wines U, V, W, X, Y and Z, and terminals D and P (bottom of Figure) are also illustrated and similarly annotated in Fig 13

FIG.11, BENCH WIRING DIAGRAM (SECOND CUBICLE)



NOTE (c) Annotations in parenthesis, for example (C₂₉), refer to the corresponding annotations in Fig. 4

(4) Wires U,V,W,X,Y and Z, and terminals O and P are also illustrated and similarly annotated in Fig. 12

FIG.12, BENCH WIRING DIAGRAM (THIRD CUBICLE)

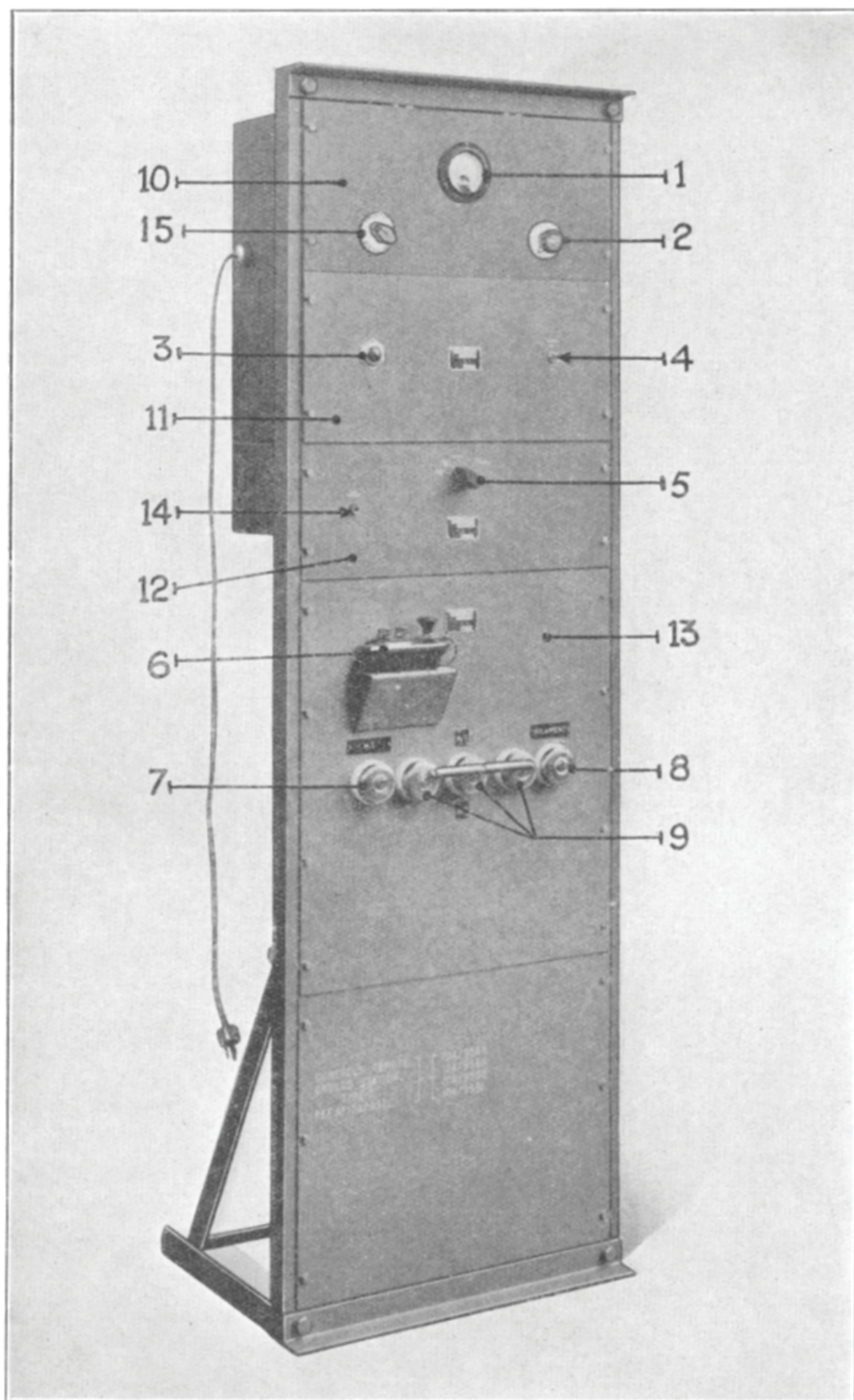


FIG. 13. Ground station remote controls, type 3.

Third cubicle

37. The lowest cubicle (rectifier cubicle not shown) seen in figs. 7, 9, and 10, houses the condensers and resistances forming the smoothing unit. In fig. 7, which shows the components from the left-hand side, the M/O and intermediate amplifier filament rheostat (15) is in the bottom right-hand corner. The two 50,000-ohm resistances (16) form part of the smoothing unit, and are represented by R_{22} and R_{23} in fig. 4. The 1.5 μ F condenser (17) on the left, is the end one of a bank of 12 such condensers which are strapped to the bottom of the M/O and intermediate amplifier cubicle.

38. In fig. 9 all 12 condensers are clearly indicated. The iron-cored choke (19) in the background, is in the H.T.+ lead and is represented by L_{15} in fig. 4. The terminal strip (20) seen in the bottom foreground is provided with eleven terminals which, if the supply is A.C., are connected by ten links to corresponding terminals on the rectifier unit. When D.C. is being used, apart from the usual H.T. and L.T. supply, a 12-volt battery is connected across the third and fourth terminals from the left and is used to operate the solenoids of the keying relay, the H.T. and aerial switch, and the L.T.— contactor.

39. Referring to fig. 10, a contactor (13) can be seen in the centre of the lowest cubicle. It is connected in the L.T.— line and its solenoid is controlled by the tumbler switch (19, fig. 1). The 1.5 μ F condenser (14) is the right-hand end condenser of the bank of 13 condensers forming the smoothing unit. The power amplifier filament rheostat (15) is visible in the bottom left-hand corner. It is controlled by the knob (21, fig. 1).

Remote controls.

40. Fig. 13 is a front view of ground station remote controls, type 3, as installed at the transmitter end. The top panel (10) carries the amplifier, which consists of an indirectly-heated triode, transformer-coupled to two triodes in push-pull, the latter forming the output stage. A milliammeter (1) reading 0–150 is connected in the H.T. feed to the output stage, and a potentiometer operated by the handle (2) is connected across the grid-filament of the first valve. A modification subsequently made in the amplifier panel introduced an attenuator. The knob (15) for controlling this may be seen to the left of the potentiometer handle.

41. The second panel (11) is the rectifier unit which incorporates a mains transformer, with five secondary windings, a double wave rectifying valve and a smoothing circuit. Of the five windings on the mains transformer, two 4-volt windings supply the filaments of the first and second stages of the amplifier, and the filament of the oscillator valve on the local control panel. Another winding supplies the anodes of the double wave rectifier (1,000 volts) and another the filament (4 volts) of the rectifier. The remaining winding gives a 10-volt supply to a metal rectifier situated in the local control panel (12). A tumbler switch (4) on the front of the panel switches the primary of the mains transformer across the supply, and a pilot lamp (3) connected across a 2-volt tapping on one of the secondaries gives a visual indication that the transformer is energized. A thermal relay is also incorporated in this panel which delays the connection of the output H.T. until the valve filaments have reached their working temperature.

42. The third panel (12) is the local control panel. This panel carries an indirectly heated triode coupled as a 1,000 c/s oscillator; this panel also carries two transformers, one for the local microphone and one for use when telephony is being carried out from a remote position on an incoming line. A metal rectifier is provided for the purpose of rectifying the 10-volt A.C. supply obtained from the winding on the mains transformer (previously referred to) and this is smoothed and provides the supply for operating the local microphone. On the front of the panel

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is the jack (14) and the 4-position switch (5) ; the former receives the plug from the local microphone. The latter is engraved at its four positions, 600 OHM INPUT, DIRECT GRID, OSCILLATOR, LOCAL MICROPHONE. In the first-mentioned position the secondary of the " line transformer " is connected across the input to the amplifier to produce a suitable matching of the amplifier input to an incoming 600-ohm line. In the second position the transformer is cut out, and the input of the amplifier is connected directly to two terminals marked 50,000 OHMS, DIRECT GRID in order that the input may be matched to any incoming line. In the third position the oscillator is connected to the input of the amplifier. In the fourth position the secondary of the local microphone transformer is connected to the input of the amplifier. In this position, owing to the mechanical coupling of a D.P. switch, the microphone primary circuit is energized from the metal rectifier.

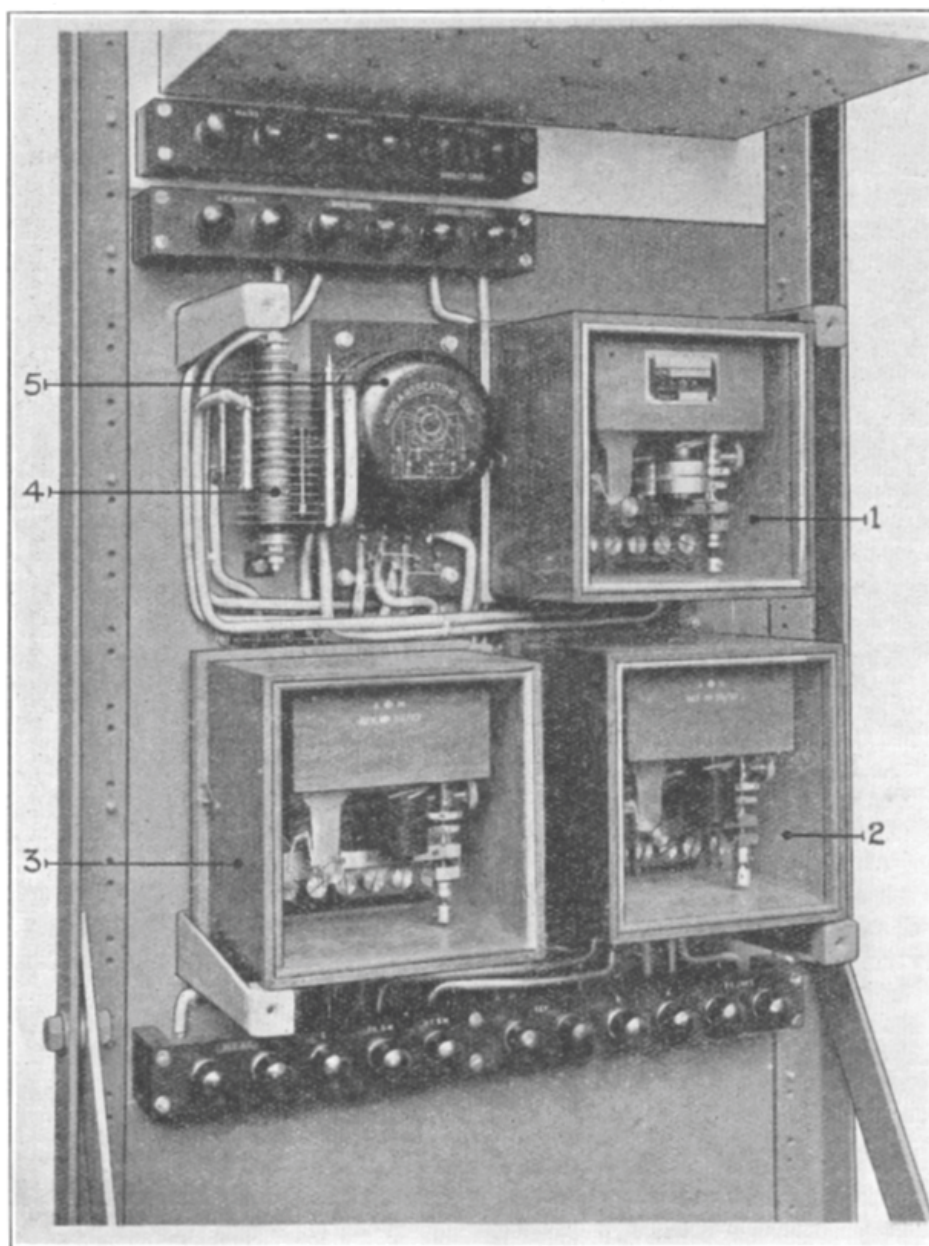


FIG. 14. Rear view of remote control panel.

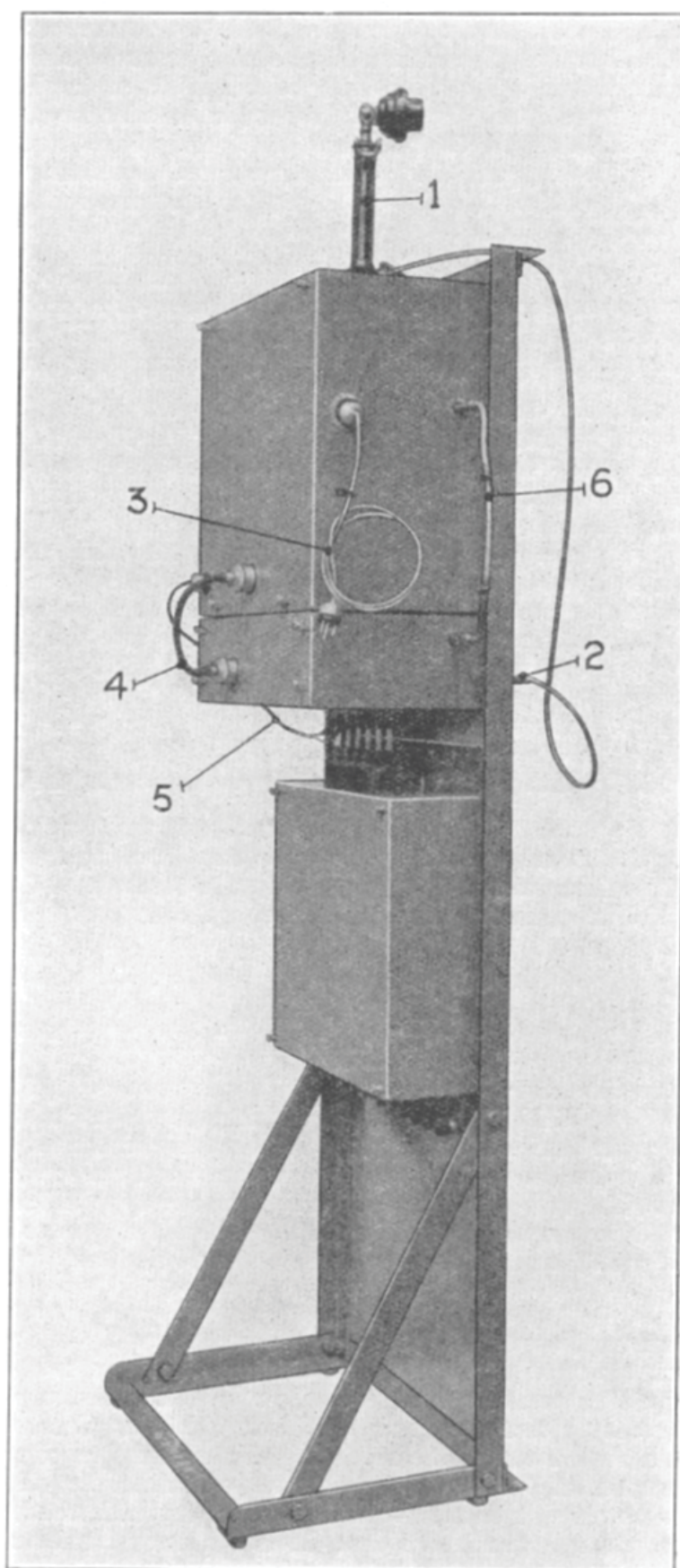


FIG. 15. Rear view of remote controls, type 3.

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43. The fourth panel (13) is the remote control panel. On the front of this panel is mounted the morse key (6), the H.T. switch (7), the filament switch (8) and the three coupled switches (9). The rear of this panel can be seen in fig. 15 in which the relay (1) is the keying sounder relay which effects the keying of the transmitter. The relay (2) immediately below this is the H.T. sounder relay which switches the H.T. supply to the transmitter. The relay (3) on the left of this is the filament sounder relay which energizes the filament relay and so switches the filament circuits of the transmitter. To the left of the relay (1) can be seen the metal rectifier (4) and the repeating coil (5).

44. The switch (9, fig. 13) is a three pole two-position switch. Two of the poles change over the connections of the repeating coil secondary from the amplifier input to the 14-volt A.C. supply and rectifier. The former is the R/T position and the latter is the W/T position. The third pole merely short-circuits the tongue and mark terminals of the keying relay in the R/T position.

45. Connections between the various panels are made by means of plugs and sockets and links. Referring to fig. 14, the microphone (1) is connected by a screened lead terminating in a plug (2) which engages with the socket (14, fig. 13). The screened lead (3) effects the connections between the output of the amplifier and the appropriate circuit of the transmitter. The screened cable (4) terminates at each end in a six-point socket. These sockets engage with plugs one of which is situated on the amplifier and the other on the local control panel. This cable carries the filament A.C. supply for the oscillator valve, the A.C. supply to the microphone rectifier, and the smoothed H.T. supply for the oscillator anode supply. The screened cable (5) is connected at one end to the A.C. mains terminals, and terminates at the other end in a two-point socket which engages with a two-point plug connected to the primary winding of the rectifier transformer. The screened cable (6) terminates at each end in a plug. One plug is inserted into a jack on the amplifier and the other is inserted into a jack on the local control panel. This provides the connection between the input of the amplifier and the output of the local control panel. The form of the output may be either speech or a 1,000 c/s audio-modulating frequency for the production of M.C.W.

46. Referring to fig. 15, it will be seen that a row of six terminals is provided at the top of the remote control panel for convenient linking up with a corresponding row at the bottom of the local control panel. The first pair on the left is connected directly to the A.C. supply, and is engraved accordingly. The remaining two pairs are engraved 600 OHMS and 50,000 OHMS respectively.

VALVES AND POWER SUPPLY

47. The valve used in the master-oscillator stage is a valve type V.T.26, and it has a filament voltage of 12 volts. Two V.T.26 valves, connected in parallel, are used in the intermediate amplifier stage. The power amplifier stage uses a V.T.4B valve, the filament voltage of which is 18 volts. One V.T.13C valve, fitted in an adaptor, is connected across the grid-filament circuit of the power amplifier. The valves used in the rectifier are two type V.U.29. These are vapour-filled valves and should be carefully handled in order to avoid any mercury coming in contact with the filaments. The L.T. and H.T. supplies are obtained from any convenient mains power supply.

48. The transmitter may be operated from an A.C. or D.C. supply, the A.C. system being the more usual. A detachable rectifying unit (Panel, Rectifying, Type A, Stores Ref. 10A/8068 or Panel, Rectifying, Type B, Stores Ref. 10A/11156) is provided for this purpose. When operating on D.C. the panel is removed and a dummy panel inserted in its place. The smoothing unit, which is contained in a cubicle above the rectifying unit, remains in circuit for both A.C. and D.C. When working on A.C. the power required for operating the various electro-magnetic switches and relays is obtained from metal rectifiers incorporated in the rectifying unit. When operating on D.C. the power is obtained from a 12-volt battery connected to the appropriate terminals. The transmitter terminals are connected to the rectifier terminals by means of links.

OPERATION

Transmitter tuning

49. The following is a description of the method by which the transmitter may be adjusted and some of the precautions which must be taken. When making the adjustments reference should be made to the tables 1, 2, 3 and 4, and the curves given in figs. 16, 17, 18 and 19.

50. The transmitter filaments should be switched on ten minutes or so before the commencement of routine transmission to allow the master-oscillator to reach a steady temperature and thus obviate frequency creep. The curves in figs. 16, 17, 18, and 19 giving the M/O tunings are not true calibration curves, the frequencies being only approximately correct owing to the slight variations in inductance and capacitance on different models, as well as the effect of different output load conditions. They are given as an easy guide for setting up the transmitter to a given frequency.

51. The tables 1, 2, 3 and 4 give typical settings of the various tunings corresponding approximately to the frequencies quoted, and can be used for the initial setting up to the desired frequency. When the desired frequency is intermediate between two frequencies given in the tables, the curves provide the appropriate interpolation for the M/O setting, and the remaining settings, *i.e.*, grid-bias and aerial coupling, should be interpolated roughly from the tables. The input currents tabulated are quoted for guidance only.

52. When operating on A.C. the adjustments must be carried out in the following order: Switch on the A.C. mains and also the rectifier and transmitter filaments and adjust the filament voltages to 12 volts for the master-oscillator and intermediate amplifier valves and 18 volts for the power amplifier valve, by means of the two controls on the lower part of the panel.

53. Set the master-oscillator tuning to the appropriate setting as indicated on the curve. Set the aerial loading switch and the range change switch to the appropriate positions. Set the pulse coil taps to the positions indicated in the tables and set the aerial coupling to zero. The grid-bias switches should be set to maximum, *i.e.*, stop 16. When working on the 1,500 to 2,256 kc/s band, part of the 143 to 400 kc/s band pulse coil must be short-circuited, and the short-circuiting lead provided should be engaged with plugs 32 and 39. When working on the 143 to 400 kc/s band the short-circuiting lead should be stowed on the dummy plugs provided on the right-hand side.

54. Having set the intermediate amplifier and power amplifier to the approximate settings as shown in the tables, put the voltage switch on the rectifier to the first stud (low volts) and switch on H.T. to the rectifier. The voltage should be approximately 2,000 volts. If necessary, re-adjust the filament voltage of the M/O and intermediate amplifier valves to 12 volts and that of the power amplifier to 18 volts. Switch on H.T. to the transmitter and with the key closed tune the intermediate amplifier by obtaining a maximum ammeter reading. Now set the aerial coupling condenser to its appropriate value. Press the key and tune the aerial circuit by obtaining a maximum reading in the aerial ammeter. Carefully re-tune the power amplifier circuit. This tuning is facilitated by watching for a dip in the reading of the power amplifier input milliammeter. Observing the aerial ammeter carefully, re-tune the intermediate amplifier circuit, and finally re-tune the aerial and power amplifier circuits.

55. It is essential that all setting up should be done in accordance with the figures given in the tables. If any other procedure is adopted, there is a danger that a false tuning will be obtained as a result of harmonics.

56. A final re-adjustment of filament voltages may now be made. Each filament rheostat should be adjusted in turn in order to ascertain whether a small increase or decrease of filament voltage will increase the aerial current reading, and each rheostat should be left at the optimum setting. Check the frequency by means of a suitable wavemeter. Re-tune if necessary by reference to the curves and tables.

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57. An increase of power may be obtained by putting up the voltage tap in the rectifier, but operators should find by trial the lowest power necessary for efficient communication and should use this setting for all normal traffic. After any such adjustment the frequency should be re-checked by a wavemeter. The approximate voltages obtainable on load are as follows :—

Tap 1	1,800 volts.
Tap 2	2,500 volts.
Tap 3	3,000 volts.

An additional tap is provided, but when using the rectifier with the transmitter, type T.77, this tap must not be used in any circumstances.

58. The setting up of the transmitter for frequencies between 2,000 kc/s and 2,256 kc/s calls for considerable care if the best output is to be obtained, and a number of adjustments and re-adjustments of tuning between the intermediate amplifier, power amplifier and aerial are necessary. It must be noted that for these frequencies the power amplifier circuit cannot be tuned by the method of observing the dip in anode current unless the aerial coupling is at zero. It is also important to note that the aerial specified requires a series capacitance of $100\mu\text{F}$ (a No. 7 condenser set at 0.10 is near enough) to give the best results on these higher frequencies.

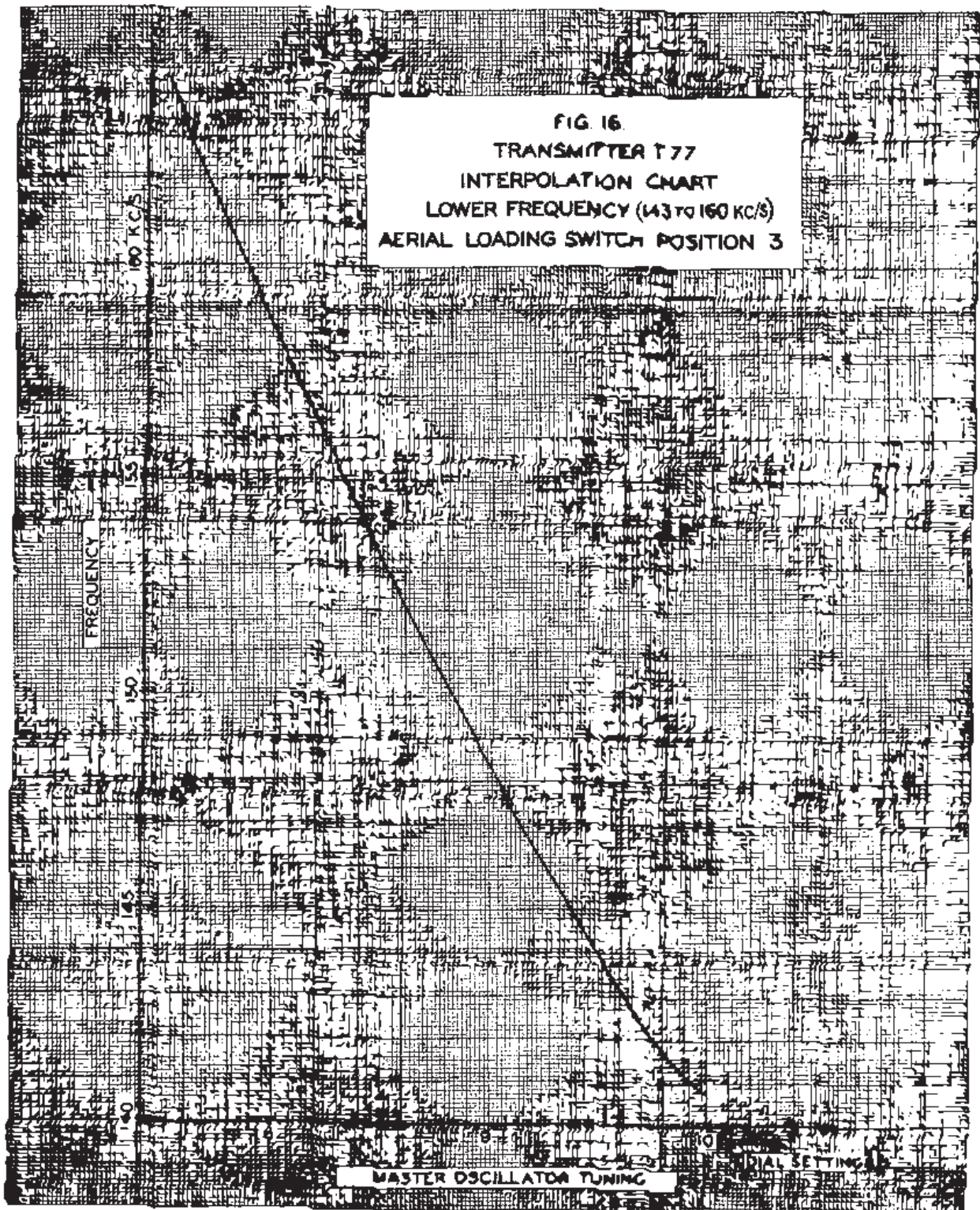
Examples showing method of using tables and curves

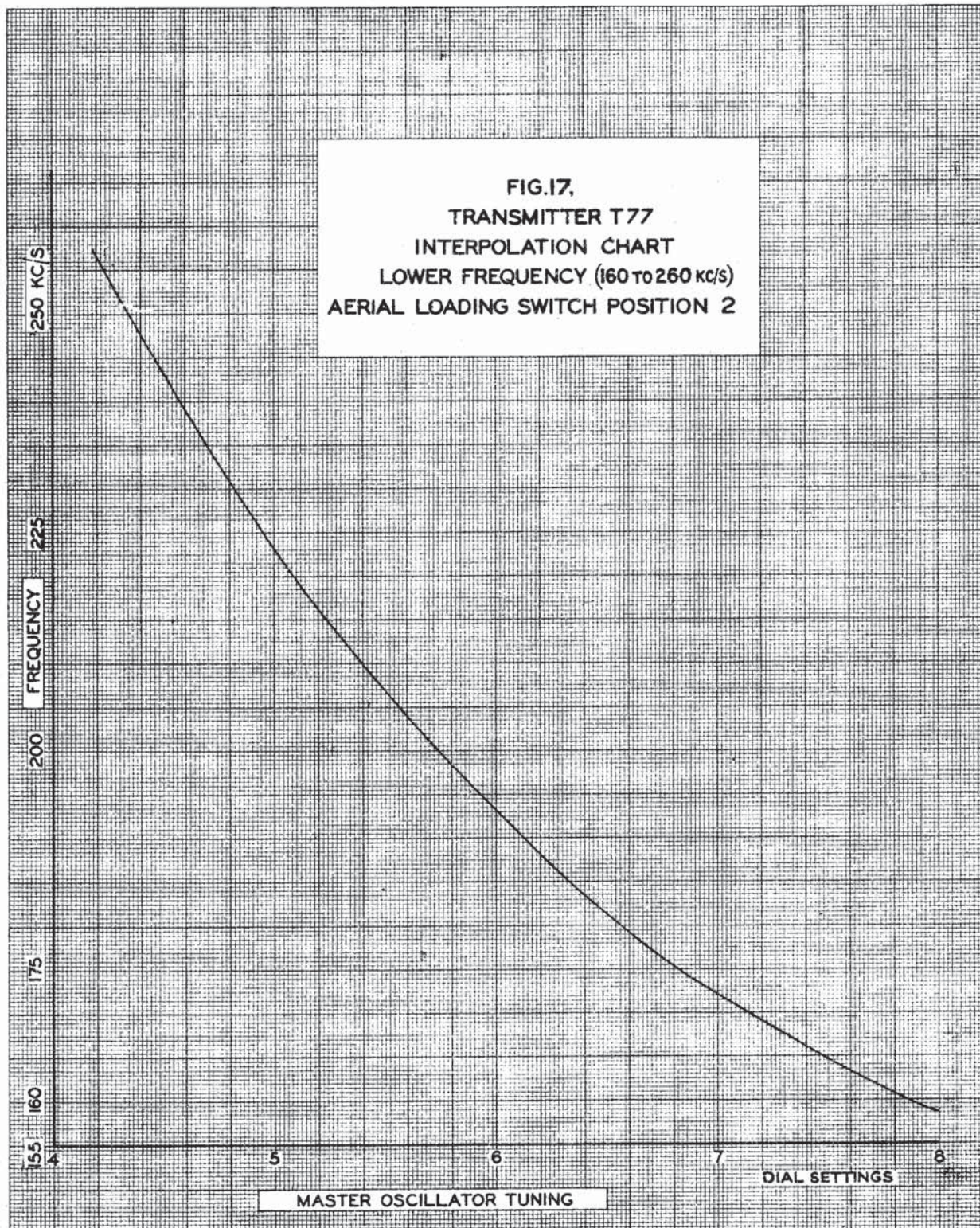
59. Suppose it is required to set the transmitter to 150 kc/s the dial setting corresponding to this frequency (see fig. 18) is 8.81. Set the M/O coil to this reading and tune the transmitter as described above using Table 1. Ascertain the actual frequency radiated by means of a suitable wavemeter or syntonizer. Assume it is found to be 150.8 kc/s, which is 0.8 kc/s high. Now look up this frequency (150.8 kc/s) on the curve (fig. 16) and it will be found to correspond to a dial setting of 8.74. The difference between the first dial setting (8.81) and the setting actually obtained on the transmitter (8.74) is .07. In this region of the curve, therefore, a difference of .07 in the setting corresponds to 0.8 kc/s. Since it is required to lower the frequency by 0.8 kc/s the M/O inductance dial setting should be increased by .07. That is, the transmitter must be set to 8.88 instead of 8.81.

60. In the higher frequency band assume it is required to set the transmitter to 1,800 kc/s. The dial setting corresponding to this frequency (see fig. 19) is 3.93. Set the M/O coil to this reading and tune the transmitter as previously described using Table 4. Determine the actual frequency radiated by means of a suitable wavemeter. Suppose the frequency obtained by the wavemeter is 1,790 kc/s, *i.e.*, 10 kc/s too low, on looking up this frequency (1,790 kc/s) on the curve, it will be found to correspond to a setting of 4.00. The difference between the dial setting read off (3.93) and the dial setting actually obtained on the transmitter (4.00) is .07. In this region of the curve, therefore, 10 kc/s corresponds to a difference in the dial setting of .07. Since it is desired to raise the frequency by 10 kc/s, the M/O inductance dial setting should be lowered by .07, *i.e.*, the transmitter must be set to $(3.93 - .07)$ 3.86. The other curves (figs. 17 and 18) may be used in a similar manner, bearing in mind that the turns are increased to lower the frequency, and reduced to raise the frequency.

Adjustments for R/T and M.C.W.

61. The operations described above for setting up the transmitter for C.W. should first be carried out. The intermediate amplifier bias control should now be set to stud 16 and the bias of the power amplifier adjusted so as to reduce the aerial current by 50 per cent. The connector from the speech amplifier may now be plugged into the socket on the side of the transmitter and modulation checked by means of the Modulation Indicator, type 1. If a modulation indicator





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is not available the aerial ammeter should be watched while speaking into the local microphone. There should be an increase in the reading of aerial current with no appreciable change of input to the amplifier valve. With 100 per cent. modulation the aerial current should rise 22 per cent. It should be borne in mind, however, that for normal speech no such increase will be observed on the aerial ammeter. With normal speech the modulation varies, even falling to zero during pauses. The average variation must therefore be considered and the average increase of the aerial ammeter reading may be no more than about 5 per cent. Since the aerial current for R/T will be of the order of 2.0 amperes this will be equivalent to an increase of 0.1 amperes.

62. If, however, a loud "hello-o-o" is sustained when testing, conditions more nearly approaching 100 per cent. modulation are obtained, and a rise of about 15 per cent. in aerial current may be effected. It should be borne in mind that it is quite impossible, no matter what depth of modulation is used, to obtain good speech if the aerial current is too high.

63. When using remote controls, type 3, the coupled switches on the remote control panel and the 2-way switch at the signals office end must be at R/T. The amplifier output connector must be plugged in and the switch on the local control panel (5, fig. 13) turned to 600 OHM INPUT. The grid-bias must be adjusted as stated in para. 61. If telephony is to be transmitted from an incoming line connected to the 50,000 OHMS terminals, the switch on the local control panel must be turned to the corresponding position. The main supply switch on the speech input amplifier must also be closed. The filament and H.T. supplies to the transmitter must then be switched on by closing the local tumbler switches. The circuit is arranged so that the H.T. cannot be switched on before the filaments.

64. When it is desired to transmit M.C.W. the connector from the remote control amplifier should be plugged into the side of the transmitter and the selector switch on the local control panel set to OSCILLATOR. The tumbler switch on the rectifier panel should be switched on, and the coupled tumbler switches placed in the W/T position. The input potentiometer should be adjusted to give the correct modulation.

PRECAUTIONS AND MAINTENANCE-

65. Switch off the H.T. before making any adjustments to the transmitter. Safety switches are provided which cut off the H.T. supply when any of the transmitter doors are opened, but it is advisable not to depend entirely on these. For remote operation of the transmitter, all tumbler switches on the front panel of the transmitter must be in the "on" position, and of course all the doors must be closed.

66. The rectifier is similar to that described in another chapter of this publication, and similar precautions must be observed. The valves used in the rectifier are two type V.U.29 valves. These valves are of the mercury-vapour type and whenever there is any possibility of the mercury having come in contact with the filaments, the filament circuit should be switched on for not less than ten minutes prior to the H.T. being switched on, or the valves may be seriously damaged. This applies in any instance where a valve is shifted, or where the complete panel has been shifted and has been subjected to any inversion or heavy vibration.

67. The output voltage from the rectifier may be varied within limits. Four transformer taps are provided for this purpose as follows:—

Tap 1 ..	..	1,800 volts.
Tap 2 ..	..	2,500 volts.
Tap 3 ..	..	3,000 volts.
Tap 4 ..	..	3,500 volts.

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68. Although four tapping points are provided, the fourth or highest tap must not be used with this transmitter. The R/F voltages generated with this high value of H.T. (3,500) are beyond the safe limit value of the insulation.

69. The valve used in the power amplifier stage is a V.T.4.B. valve. Some of these valves are prone to secondary grid emission. If any valve bearing one of the serial numbers from 2057 to 2684 is fitted, the power amplifier input milliammeter should be carefully watched as the H.T. is switched on. If a surge occurs, switch off immediately and increase the power amplifier filament volts a little. Switch on the H.T. again and watch the milliammeter. Increase the filament volts if necessary until there is no tendency to surge after switching on.

70. Care should be exercised that the correct fuses are fitted in the rectifier. There are four of these fuses each of which should carry two strands of 33 s.w.g. tin wire.

71. The relay, type K, which breaks the H.T. supply from the rectifier is situated in a glass-fronted box on the side of the unit. The contact arms should be adjusted so that when the relay is energized, the lower or L.T. contact arm makes first and the upper or H.T. contact arm makes a fraction of a second later. Each contact arm is provided with a carbon and a metal contact, and it should be adjusted so that the carbon contact makes before the metal contact.

TABLE 1

H.T. Voltage, Tap 2 (2,600 volts on load)

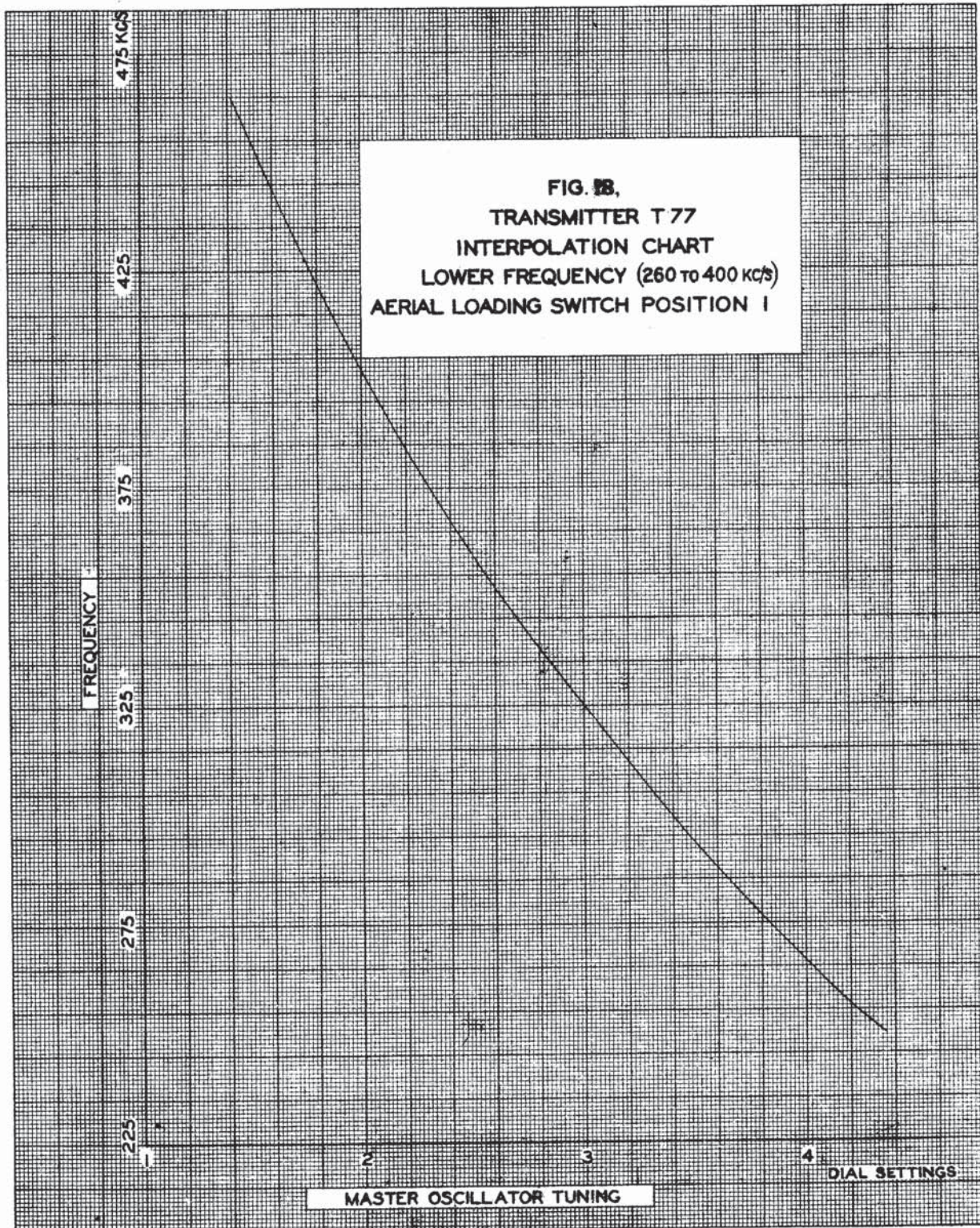
Range change switch position (143 to 400 kc/s)

Aerial loading switch, position 3

Aerial 1,100 μ F (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts)

Radial earth system.

kc/s.	Pulse Coil.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Long Wave.										M/O.	INT. AMP.	POWER AMP.	
	Max.	Coup- ling.	H.T.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.	M/O.					
142.9	33	33	42	9.60	9.23	6.74	6.50	4	11	120	89	45	170	4.9
148.4	33	33	42	9.00	8.68	6.22	5.68	4	9	120	66	43	173	4.9
153.1	33	33	42	8.50	8.20	5.94	5.30	3	10	120	72	57	170	4.9
158.3	33	33	42	8.00	7.72	5.62	4.83	4	6	120	68	45	175	5.0
164.4	33	33	42	7.50	7.23	5.25	3.43	3	5	120	72	60	170	4.8



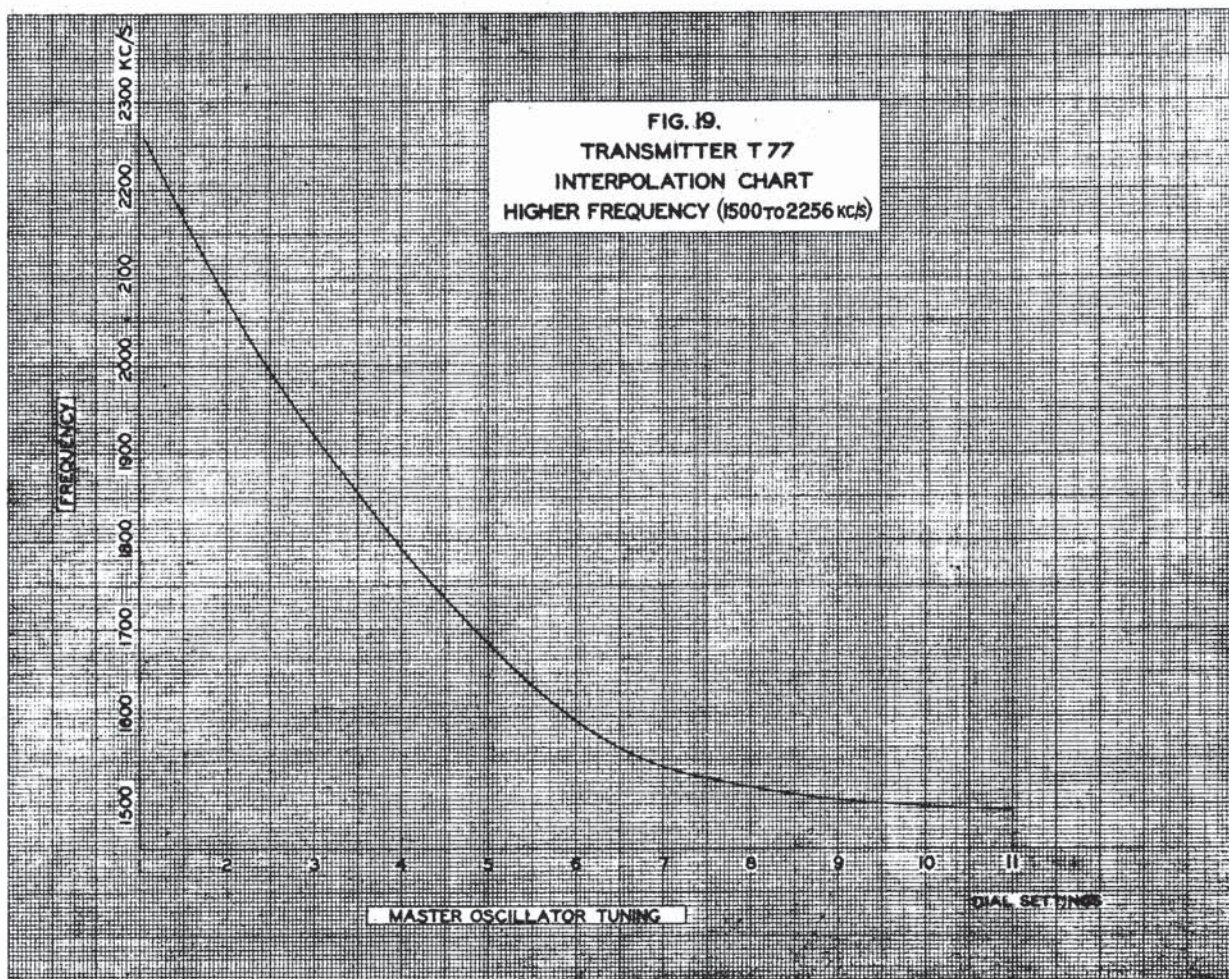


TABLE 2

H.T. Voltage, Tap 2 (2,600 volts on load)

Range-change switch position—(143 to 400 kc/s)

Aerial loading switch, position 2

Aerial 1,100 μF (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts) Radial earth system.

kc/s.	Pulse Coil.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Long Wave.										M/O.	INT. AMP.	POWER AMP.	
	Max.	Coupling	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.		M/O.	INT. AMP.	POWER AMP.	
158.3	33	33	42	8.00	7.74	5.56	9.43	4	14	120	66	40	175	4.7
168.5	33	33	42	7.20	7.00	5.00	7.52	3	13	85	68	50	170	5.0
176.5	33	33	42	6.77	6.58	4.83	6.73	3	13	90	64	45	170	4.8
185.7	33	33	42	6.20	6.04	4.36	5.73	3	11	57	68	50	170	4.9
199.6	33	33	42	5.74	5.62	4.00	5.03	3	11	63	64	47	170	4.9
215.8	33	33	42	5.20	5.17	3.50	4.10	3	10	57	68	50	170	4.9
230.8	33	33	42	4.78	4.67	3.06	3.18	3	6	60	66	48	170	4.9
256.4	33	33	42	4.20	4.19	2.45	1.62	3	4	120	72	55	170	4.6

TABLE 3

H.T. Voltage, Tap 2 (2,600 volts on load)

Range switch position—(143 to 400 kc/s)

Aerial loading switch, position 1

Aerial 1,100 μF (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts) Radial earth system.

Kc/s.	Pulse Coil.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Long Wave.										M/O.	INT. AMP.	POWER AMP.	
	Max.	Coupling	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.		M/O.	INT. AMP.	POWER AMP.	
245.9	33	33	42	4.40	4.30	9.97	4.80	3	9	80	70	50	170	4.6
266.2	33	33	42	4.00	3.97	8.01	4.29	2	6	65	74	55	170	4.9
291.8	33	33	42	3.50	3.35	6.28	3.64	2	6	45	74	50	170	4.7
326.8	33	33	42	2.95	2.79	5.32	2.89	2	3	35	74	66	170	4.6
366.0	33	33	42	2.40	2.28	4.46	2.10	1	2	45	74	50	170	4.2
409.8	33	33	42	1.90	1.80	3.78	1.46	1	1	65	80	82	200	4.0

SECTION 1, CHAPTER 2

TABLE 4

H.T. Voltage, Tap 2 (2,600 volts on load)

Range switch position—(1,500 to 2,256 kc/s)

Aerial loading switch, position 1

Aerial (vertical cage type, 6 wires spaced 12 in. diameter, top 50 ft.) Radial earth system.

kc/s.	Pulse Coil.			Tuning.					Bias.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Anode.	Coupling.	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL.		INT. AMP.	POWER AMP.		M/O.	INT. AMP.	POWER AMP.	
							Vario- meter.	Series Con- denser							
1,474	1	6	31	10.86	5.32	4.04	3.41	Nil	10	4	63	50	62	170	4.5
1,506	1	6	31	9.00	5.28	3.98	3.37	Nil	10	4	62	54	62	170	4.6
1,526	1	6	31	7.00	5.00	3.72	2.95	Nil	10	4	60	55	62	170	4.3
1,550	1	6	31	6.00	4.69	3.52	2.65	Nil	10	4	60	56	65	170	4.0
1,577	1	6	31	5.50	4.47	3.23	2.35	Nil	10	4	80	54	60	170	3.8
1,605	1	6	31	5.00	4.14	2.85	2.02	Nil	10	1	80	54	57	170	4.0
1,655	1	6	31	4.50	3.74	2.29	1.68	Nil	10	1	80	58	57	150	3.6
1,717	1	6	31	4.00	3.26	2.07	1.06	Nil	8	1	90	57	65	175	3.7
1,717	1	6	31	4.00	3.31	2.17	1.89	980	7	4	80	60	66	165	4.1
1,792	1	6	31	3.50	2.81	1.71	1.65	980	7	5	120	60	67	170	3.7
1,860	1	6	31	3.0	2.32	1.24	0.96	980	5	3	120	62	76	170	3.6
1,947	1	6	31	2.5	1.87	0.94	0.56	980	4	1	120	64	84	150	3.2
1,947	1	6	31	2.5	1.93	2.17	7.13	150	4	5	120	65	75	170	3.4
2,040	1	6	31	2.0	1.51	1.05	5.13	150	3	3	80	65	82	175	3.4
2,165	1	6	31	1.5	1.07	0.47	3.39	150	2	1	55	64	92	170	3.2
2,199	1	6	31	1.35	0.95	0.20	2.85	150	1	1	60	62	100	160	2.8

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/8151	Transmitter T.77		Complete without valves.
10A/8297	Principal components :— Adaptor, grid, amplifier valve	1	Fitted with one valve-holder 10A/3412 and four resistances, type 82.
	Ammeter, thermo :—		
10A/8160	0 to 4 amps.	2	
10A/7180	0 to 6 amps.	1	
10A/3178	0 to 12 amps.	1	
	Choke, R/F. :—		
10A/8161	Type 15	1	
	Choke, A/F. :—		
10A/7512	Type C	1	
	Coil, inductance :—		
10A/8152	No. 1	3	Amplifier, intermediate circuit and M/O inductances with condenser mounting
10A/8153	No. 2	1	Aerial loading, L.W.
10A/8154	No. 3	1	Pulse coil.
10A/8155	No. 4	1	Aerial inductance.
	Condenser :—		
10A/8098	Type 146	8	1.0 μ F.
10A/8162	Type 150	1	Variable.
10A/8163	Type 151	3	.01 μ F.
10A/8164	Type 152	1	.0026 μ F.
10A/8165	Type 153	2	Variable.
10A/8166	Type 154	1	.0003 μ F.
10A/8167	Type 155	1	.000192 μ F. Bank of six units mounted on 10A/8152.
10A/8168	Type 156	2	.00103 μ F. Bank of ten units each mounted on 10A/8152.
10A/8169	Type 157	1	.0002 μ F.
10A/8170	Type 158	3	.00005 μ F.
10A/8172	Type 160	1	.000106 μ F.
10A/8206	Type 162	1	.000212 μ F.
10A/9011	Type 256	26	1.0 μ F.
10A/8157	Grid-bias unit	2	Complete with 5 resistances, type 322.
	Holder, valve :—		
10A/8173	Type G	3	M/O and intermediate amplifiers.
10A/8174	Type H	1	Power amplifier.
	Insulator :—		
10A/8093	Type 16	1	Aerial lead-in.
	Milliammeter :—		
10A/1504	0 to 100 mA	1	M/O. H.T.
10A/3191	0 to 200 mA	1	Intermediate stage H.T.
10A/3091	0 to 300 mA	1	Amplifier H.T.
10A/3092	0 to 500 mA	1	Total input.

SECTION 1, CHAPTER 2

APPENDIX—continued

Ref. No.	Nomenclature.	Quantity.	Remarks.
Transmitter T.77— <i>continued</i> Principal components— <i>continued</i>			
10A/8068	Panel, rectifying, type A	1	For A.C. supply.
10A/11156	or Panel, rectifying, type B	1	
10A/8207	Panel, dummy	1	Alternative to 10A/8068 when supply is D.C.
10A/8254	Relay, magnetic, type M	1	
10A/8158	Relay, unit	1	Complete with magnetic H.T. switch, one relay, magnetic, type N or 31, 2 condensers, type 146, and 1 resistance, type 127.
Resistance :—			
10A/7316	Type 30	2	100,000 ohms, 1-watt, rod type.
10A/7766	Type 82	4	40 ohms.
10A/8179	Type 130	2	0.85 ohms, variable.
10A/8253	Type 138	6	1.5 ohms.
10A/8607	Type 153	2	5 M Ω 1-watt, rod type.
10A/9814	Type 300	2	30,000 ohms.
10A/9816	Type 302	2	50,000 ohms.
10A/9820	Type 306	3	20,000 ohms.
10A/9821	Type 307	1	500 ohms.
Switch :—			
10A/8082	Type 75	2	Gate switch.
10A/8181	Type 78	1	Three-position switch
10A/9162	Type 97	1	Plug operated. Fitted with socket, type 19.
5C/622	Tumbler	2	
10A/8159	Variometer	4	Aerial, power amplifier, intermediate amplifier, and master-oscillator.
Voltmeter, A.C. :—			
10A/8183	0 to 15	1	M/O and intermediate amplifier filament.
10A/8184	0 to 20	1	Power amplifier filament.
Voltmeter, moving coil :—			
10A/7784	0 to 3,500	1	D.C. volts.
Accessories :—			
5A/1219	Lamp, filament, 230 V., 16 c.p... ..	1	Pilot lamp.
10A/7431	Plug, type 51	1	For 10A/9162.
10A/9167	Disc, indicating, type K	1	For 10A/7431
Valves :—			
10A/5203	Type V.T.4B	1	Power amplifier.
10A/9122	Type V.T.26	3	M/O and two intermediate amplifiers.
10A/8087	Type V.U.29	2	For rectifying panel.
10A/7510	Type V.T.13C	1	For grid adaptor.
Controls, remote, ground station :—			
10A/9009	Type 2	1	
	or		
10A/9521	Type 3	1	
	or		
10A/9522	Type 4	1	

FOR OFFICIAL USE ONLY

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July, 1939

ROYAL AIR FORCE SIGNAL MANUAL, PART IV
TECHNICAL DESCRIPTION OF APPARATUS

SECTION 1

(10) *Insert* the attached Chapter 3. Transmitter T.1087.

December, 1938

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SECTION 1, CHAPTER 3

TRANSMITTER T.1087

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TRANSMITTER T.1087

(Stores Ref. 10A./8709)

INTRODUCTION

1. The T.1087 is a ground-station transmitter designed for the transmission of C.W., M.C.W., or R/T on the frequency band 1,500 to 20,000 kc/s. Modulation is obtained from a separate amplifier such as the amplifier portion of Remote Controls, type 3 (see appropriate Section of this publication). The output from the amplifier is connected to the transmitter by means of a flexible cable and a plug which is inserted in the jack 6 (fig. 8). The transmitter may be operated either direct or by remote control over land lines. The power is normally obtained from a 230-volt 50 cycle A.C. supply, but D.C. may also be used in conjunction with a motor alternator or suitable convertor.

2. The circuit comprises a master-oscillator stage coupled to an amplifier stage comprising two screen-grid valves connected in push-pull. The output circuit consists of an auto-transformer capacitance-coupled to the amplifier circuit. The auto-transformer is provided with several taps whereby various types of aerial systems may be connected to the transmitter and by means of which the transformer ratio may be varied for matching purposes. A separate valve connected up as a rectifier is used to provide the bias for the amplifier valves.

3. A set of three plug-in coils is provided for the master-oscillator tuning inductance. A set of ten sockets is provided on the transmitter, six of which are used at a time, the coils being provided with a suitable number of lugs. The ranges covered are approximately as follows :—

Number 1 Coil	..	16,666 to 20,000 kc/s (18 to 15 metres).
Number 2 Coil	..	3,000 to 18,750 kc/s (100 to 16 metres).
Number 3 Coil	..	1,500 to 3,000 kc/s (200 to 100 metres).

The number 2 coil is adapted to be plugged into any one of four different positions. The plugs are engraved B, C, D and E to correspond to each of the positions and the corresponding ranges covered are :—

Position B	..	15,789 to 18,750 kc/s (19 to 16 metres).
Position C	..	11,110 to 15,789 kc/s (27 to 19 metres).
Position D	..	7,500 to 11,540 kc/s (40 to 26 metres).
Position E	..	3,000 to 7,500 kc/s (100 to 40 metres).

4. Provision is made for alternative values of master-oscillator anode feed resistances. When coil Number 3 is being used, two 20,000-ohm resistances are available. When the other two coils (Numbers 1 and 2) are used, two 10,000-ohm resistances are used. The resistances are of the vitreous embedded type and may be clipped into position as and when desired. When in circuit, the resistances are connected in parallel. The amplifier coil is built in and is tuned by means of taps, the frequency band being covered by various positions of these taps.

5. When transmitting W/T, the key makes and breaks the H.T., thus interrupting oscillations at the space position of the key so as to facilitate listening-through, but during stand-by periods the oscillations are automatically set up again, so as to maintain the temperature of the components of the tuned circuit of the master-oscillator. This stand-by, or space-tuning frequency is adjustable and will not, in general, be the same as the signalling frequency.

6. The change-over to space-tuning frequency occurs automatically if a pause of more than 10 seconds is made in transmission, when a number of relays included in the circuit are energized and perform various switching operations. In addition to switching over the master-oscillator to the space-tuning frequency, the amplifier is rendered inoperative and the aerial and earth are disconnected.

SECTION 1, CHAPTER 3

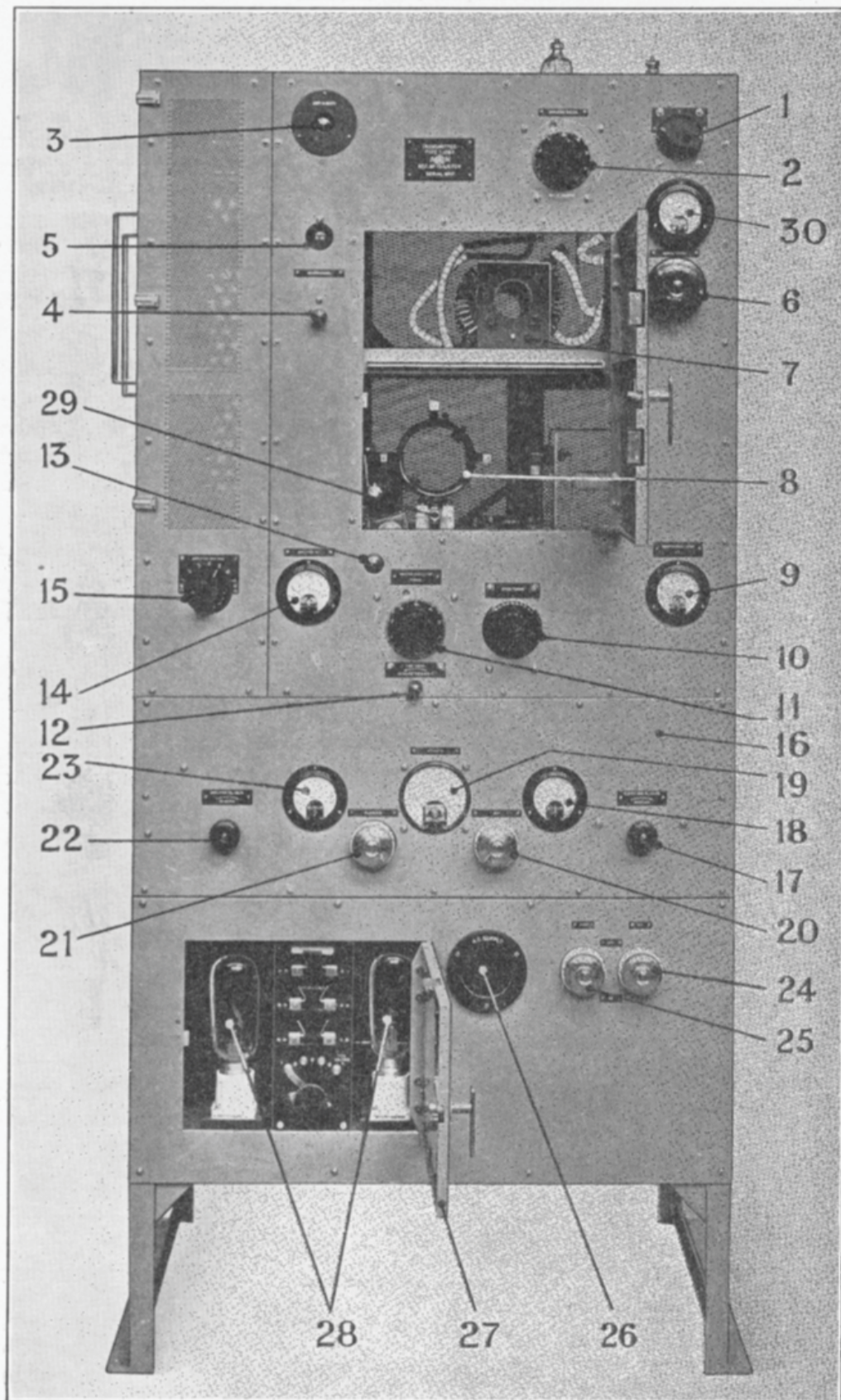


FIG. 1. Transmitter T1087.

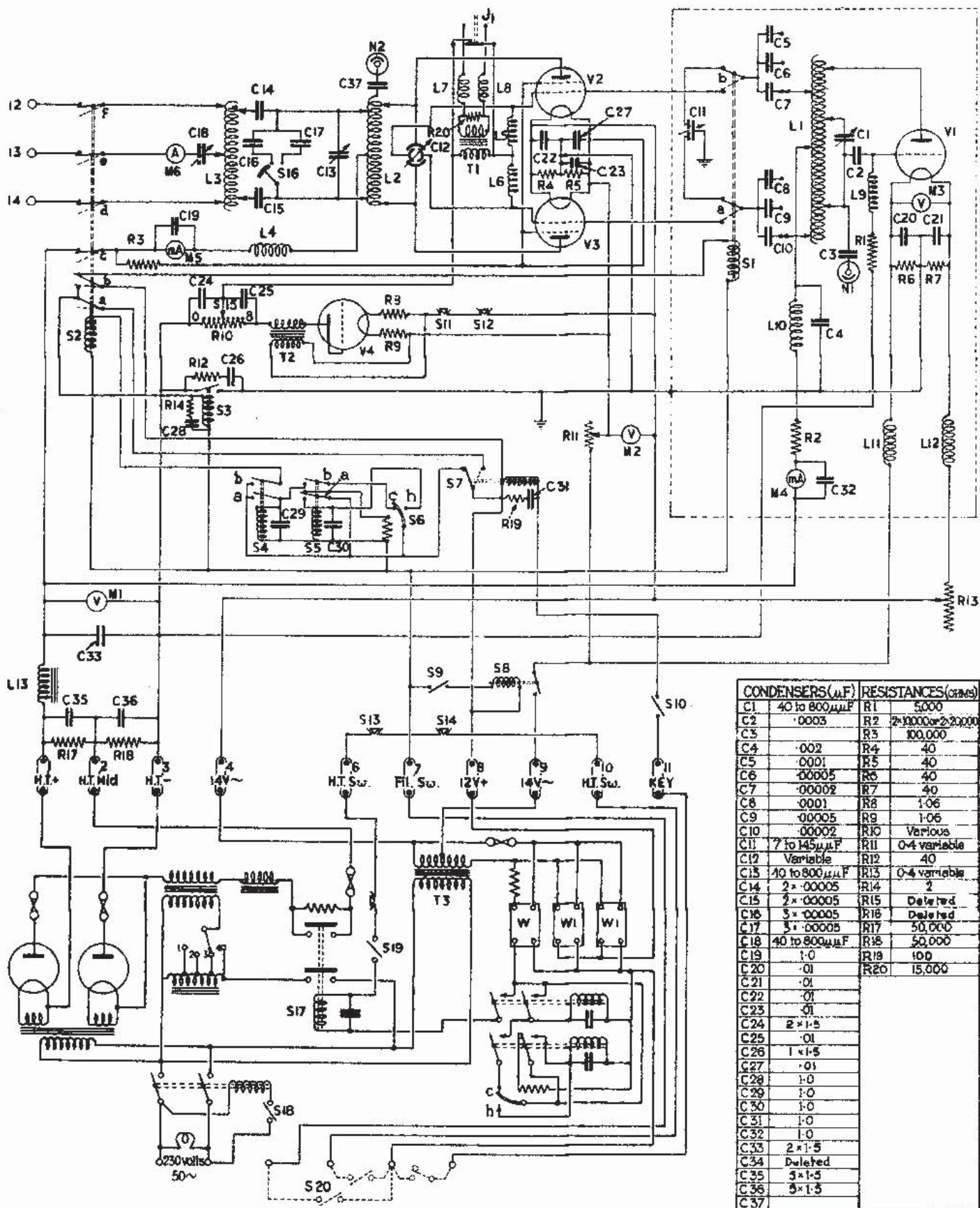


FIG. 2. THEORETICAL CIRCUIT DIAGRAM

GENERAL DESCRIPTION

7. A circuit diagram of the transmitter is given in fig. 2. It consists of a master-oscillator valve V_1 connected up as a Hartley circuit. The tuned inductance L_1 may consist of one of a set of three plug-in coils provided with six tapping points. C_1 is the tuning condenser and C_2 the grid blocking condenser. A neon lamp N_1 is coupled to L_1 by the condenser C_3 and serves to indicate when the master-oscillator is oscillating. The grid leak R_1 and choke L_4 are connected between the grid and H.T.—. A connection is made directly from H.T.+ through the anode resistance R_2 and milliammeter M_4 , the latter shunted by the condenser C_{32} , to a tap on the inductance L_1 , an R/F choke L_{10} and by-pass condenser C_4 being also included in this circuit.

8. Two chokes L_{11} and L_{12} are included in the filament leads of the M/O, while the rheostat R_{13} varies the applied voltage. A filament equalizing unit consisting of the two condensers C_{20} and C_{21} and the resistances R_6 and R_7 is connected across the valve filaments. The voltmeter M_3 indicates the applied filament volts.

9. The M/O and amplifier are capacitance-coupled through the condensers C_5 , C_6 , C_7 , C_8 , C_9 and C_{10} , which are so arranged that the appropriate pair is selected by the coil L_1 when it is inserted in position. The relay S_1 has two positions such that when the key is down the relay is energized, and the output from the M/O is connected to the amplifier. If, however, the key is up for more than 10 seconds, S_1 is de-energized and the M/O circuit is connected to the condenser C_{11} and oscillation continues but at some pre-determined space-tuning frequency. Should this cause interference to the reception of weak signals in a near-by receiver, the space-tuning frequency may be adjusted by C_{11} to eliminate such interference.

10. Two screen grid valves V_2 and V_3 are used in the amplifier stage and are connected in push-pull. The filaments are in parallel and are fed from the rectifier unit at the bottom of the transmitter. The unit is Rectifier, type B (Stores Ref. 10A/8067) which is described elsewhere in this publication. A rheostat R_{11} controls the voltage applied to the amplifier valve filaments and also the voltage applied to the filament circuit of the rectifier valve V_4 . The volt-meter M_2 measures this voltage. A filament equalizing unit consisting of the condensers C_{22} and C_{23} and the resistances R_4 and R_5 is connected across the filaments of the valves V_2 and V_3 . The screen grids of the valves are connected to H.T.+ through the dropping resistance R_3 and are maintained at practically earth potential (R/F) by the condenser C_{27} connected between the screen grids and filament.

11. The socket J_1 provides the means of connecting the output of the external amplifier to the modulating transformer T_1 . The two chokes L_7 and L_8 are in series in each side of the primary winding, and a 15,000-ohm. resistance R_{20} is connected across the primary winding to act as a speech improver. When the plug is withdrawn from the jack the secondary winding of the transformer is short-circuited. The amplifier circuit is tuned by means of taps on the coil L_2 and the variable tuning condenser C_{13} . A neon lamp N_2 , coupled by the condenser C_{37} , indicates excitation of the tuned anode coil L_2 . In addition to the variable condenser C_{13} , two fixed condensers C_{16} and C_{17} are provided. One or both of these may be connected in parallel with C_{13} by means of the switch S_{16} . The various circuit connections to L_2 are made through connecting links. In order to prevent feed-back on the higher frequency settings, a neutralizing arrangement consisting of the differential condenser C_{12} is connected between the anodes and grids of the valves V_2 and V_3 .

12. The H.T.+ feed for the amplifier valves is connected to the centre-point of L_2 . A milliammeter M_5 , shunted by the condenser C_{19} , and a choke L_4 are included in this circuit. Also in this circuit is the contact c of the relay S_2 . The H.T.— side of the valves V_1 , V_2 and V_3 is connected back through the relay S_2 , the contacts of which are shunted by the resistance R_{12} and condenser C_{28} in series.

SECTION 1, CHAPTER 3

13. Grid-bias for the valves V_2 , V_3 , is obtained from the rectifier valve V_4 . The primary winding of T_2 is connected across the filament supply for V_4 which is obtained from the 50 cycle A.C. mains. The grid and anode of V_4 are strapped together so that the valve functions as a diode. The anode circuit includes the secondary winding of T_2 , the grid-bias resistances R_{10} and condensers C_{24} and C_{25} . The end of R_{10} marked S is at negative potential with respect to the end marked 0, and the tapping point of R_{10} applies a negative bias to the grids of V_2 and V_3 via the chokes L_5 and L_6 . When the key is pressed, however, the end of the resistance marked 0 is connected directly to the filament centre-point.

14. The output from the amplifier stage is connected through the blocking condensers C_{14} and C_{15} to the auto-transformer L_3 which consists of a coil, each turn of which is tapped and is provided to enable the transmitter to work into any type of load. The various connections are made by means of sockets, the transformer ratio being varied, for matching purposes, by changing the positions of the sockets on the input side and also those on the output side. Three aerial terminals are provided, two of which are connected by sockets to the output side of L_3 (12 and 14) and the third terminal 13 is connected to L_3 through an ammeter M_6 and variable condenser C_{18} .

15. The terminal 13 is provided to enable an aerial of the $\frac{1}{4}$ wavelength type to be used, for example when working on the higher frequencies. When the aerial is connected to terminal 13, the aerial circuit can be tuned by C_{18} , variation of coupling being effected by adjustment of the taps on the output transformer. If open wire transmission lines are used, they are connected to terminals 12 and 14. When connected thus, it is necessary to use matched ammeters in each of the lines, these being connected externally between the transmission lines and the transmitter.

16. The H.T. smoothing circuit consisting of the choke L_{13} , resistances R_{17} , R_{18} and condensers C_{33} , C_{35} and C_{38} is similar to the corresponding portion of the rectifier, type B. It should be noted that the lower portion of fig. 2 illustrates panel, rectifying, type A (Stores Ref. 10A/8068). Future contracts of the transmitter will have panel, rectifying, type B (Stores Ref. 10A/11156). Both types of panels are dealt with in the chapter on Rectifier, type B contained in this publication. The terminals marked 1 to 11 on the diagram represent the terminals on the transmitter which are connected up by means of links to the corresponding terminals on the rectifier unit. A 14-volt A.C. supply from the transformer T_3 is connected across the terminals 4 and 9. When the gate switches S_{13} and S_{14} are closed across terminals 6 and 10, and the H.T. switches are closed, it is possible for the H.T. relay S_{17} to become energized. A 12-volt rectified D.C. supply is connected across the terminals 7 and 8 in series with the filament switch on the remote control panel. The same 12-volt rectified supply from the metal rectifiers W_1 is connected via the terminal 8 through the relay of S_7 and the switch S_{10} to the terminal numbered 11. On closing the key, with S_{10} made, the terminal 11 is connected back to the negative side of the rectifiers W_1 and the relay S_7 operates.

17. When the main A.C. supply is connected to the 230-volt terminals on the rectifier unit, and the switches S_{18} and S_{19} are closed, after a period of about 20 seconds the H.T. supply to the transmitter becomes available. Two simplified circuit diagrams are given in figs. 3 and 4. Fig. 3 shows the condition of the various relays in the transmitter approximately 30 seconds after the switches S_{20} and S_{18} have been closed. The relays S_2 , S_3 , S_4 and S_5 are energized, the key is up, the M/O valve is oscillating but at some space-tuning frequency determined by C_{11} ; the amplifiers are disconnected from the M/O; H.T. + for the amplifiers is broken at c of S_2 , and the output circuit is broken at d , e , and f of S_2 .

18. A similar circuit is shown in fig. 4 but with the key down. The relays S_1 , S_3 and S_7 are energized. The output from the M/O is coupled to the amplifiers, the H.T. circuit of the amplifier valves is made and also the output circuit to the aerial or transmission lines, depending upon what system is being used.



FIG. 3. SIMPLIFIED CIRCUIT DIAGRAM, TRANSMITTER WARMING UP

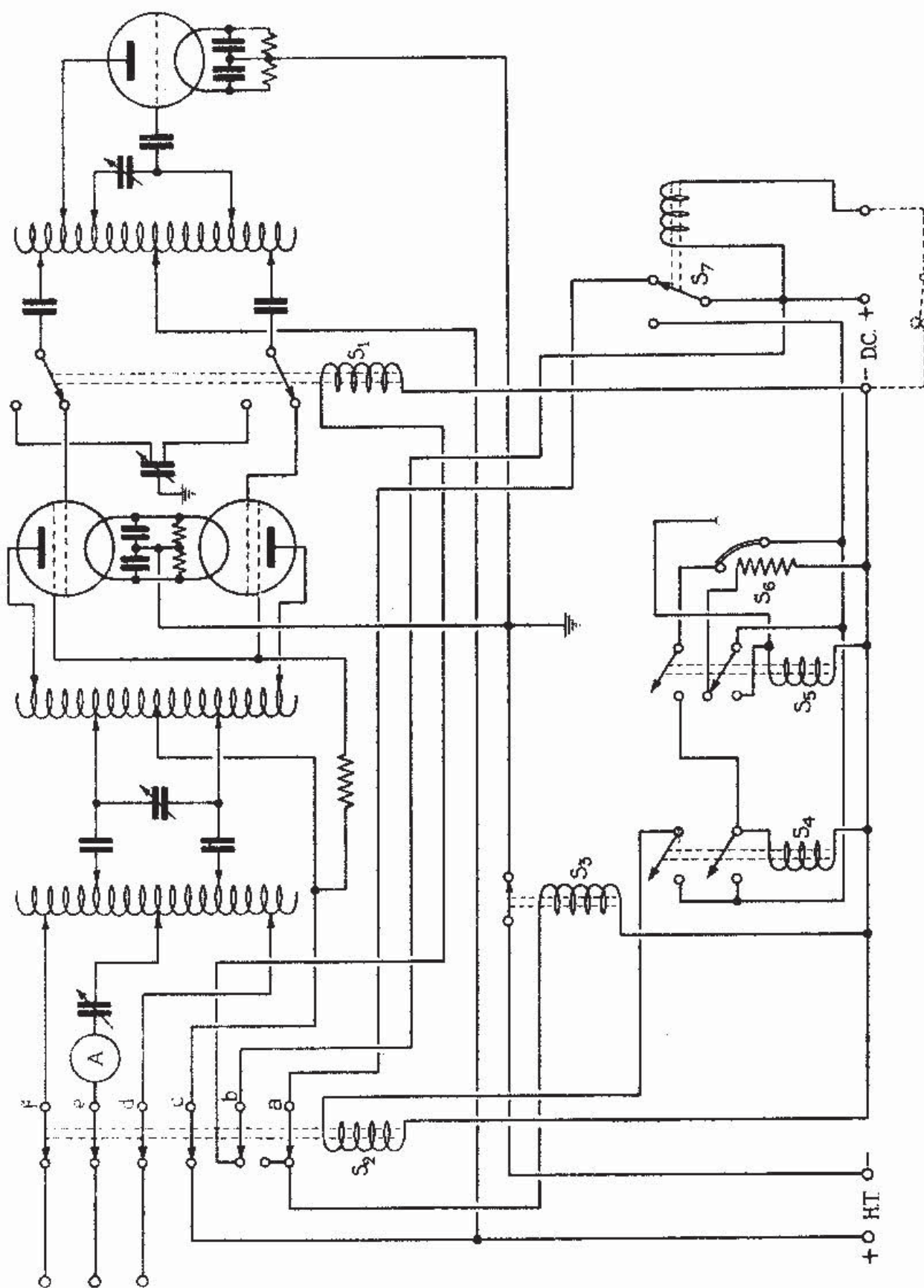


FIG. 4. SIMPLIFIED CIRCUIT DIAGRAM, KEY DOWN

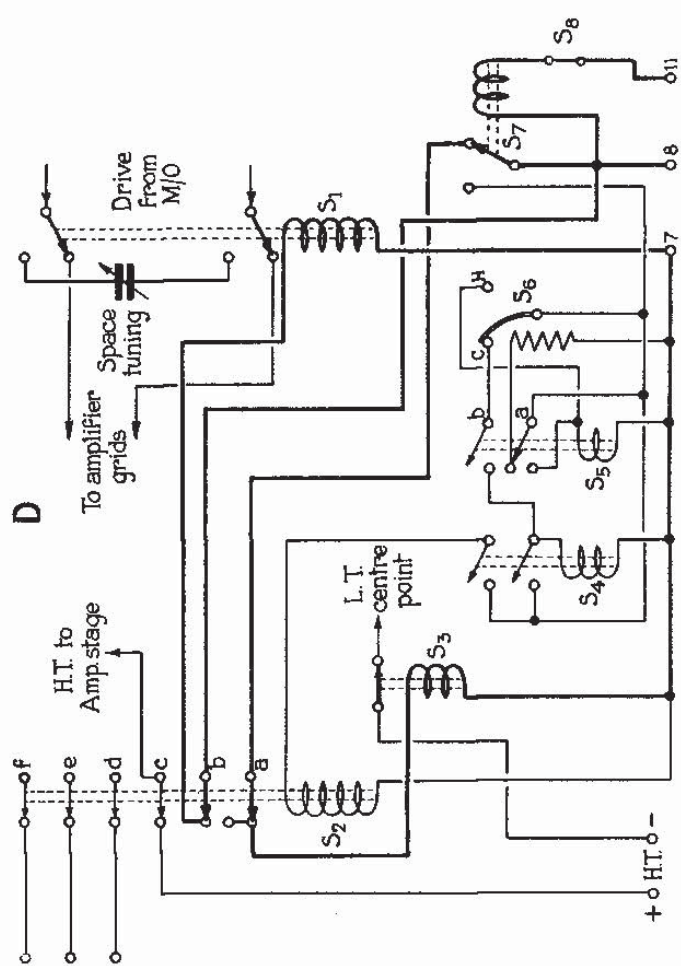
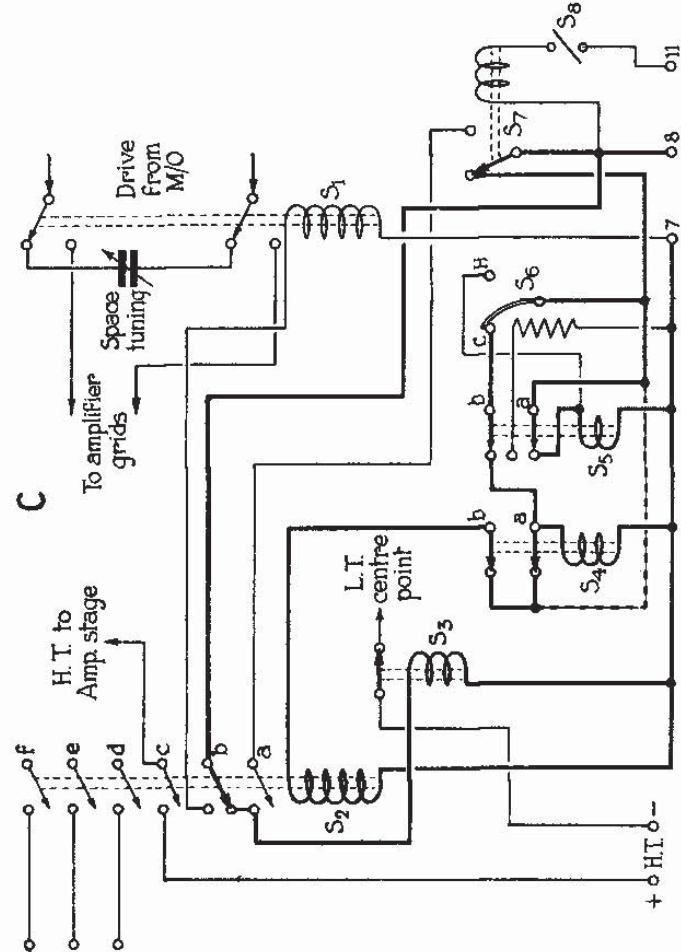
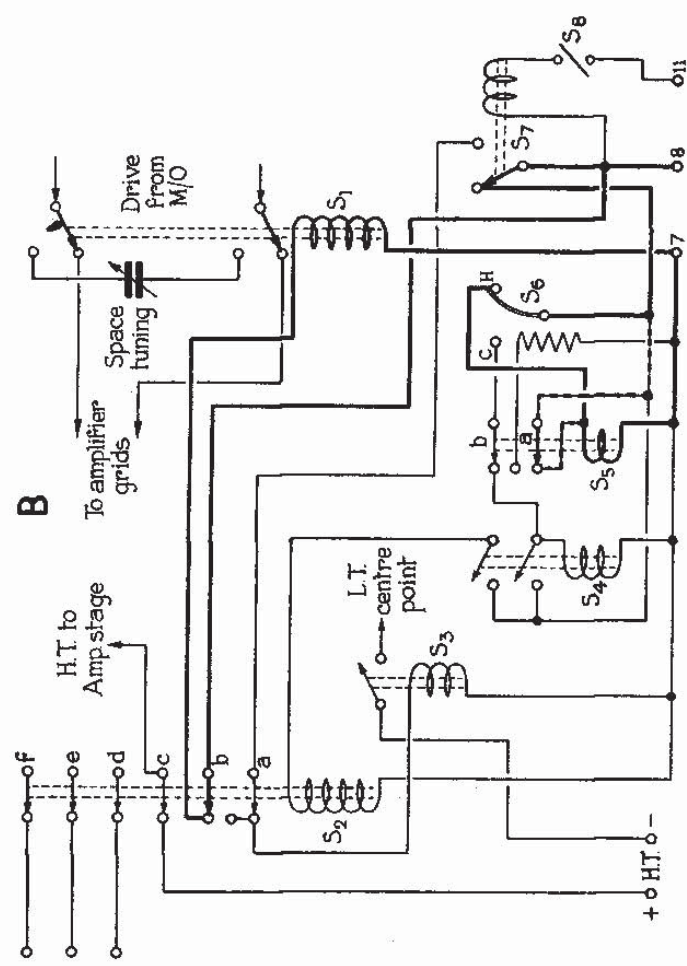
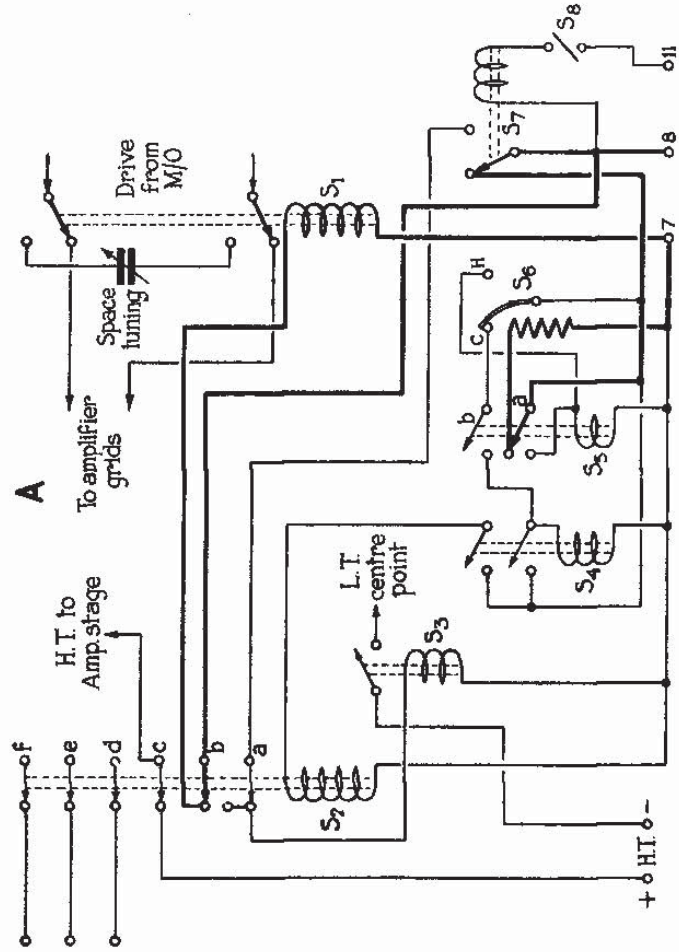


FIG. 5. SEQUENCE OF OPERATIONS DUE TO THERMAL RELAY

19. Several relays have been introduced into the circuit in order that the M/O circuit components should be maintained at a constant temperature during a pause in transmission. Fig. 5 shows the sequence of operation. As soon as the power supplies are available from the rectifier unit, a 12-volt rectified supply is connected across the terminals (7 and 8, fig. 2), the relay S_1 becomes energized through contact b of S_2 , the heating element of S_6 becomes energized through contact a of S_5 and the open-circuit contact of S_7 , and the bi-metal strip starts moving over from the C (cold) to the H (hot) contact of S_6 . These conditions are shown at A in fig. 5.

20. When the bi-metal strip reaches the H (hot) contact of S_6 , the winding of S_5 becomes energized through this contact and S_7 . S_1 remains as before, but the circuit for the heating element of S_6 is broken at a of S_5 . The relay S_5 is self-locking. As soon as the relay is energized through H of S_6 and S_7 , the circuit has two paths, one as shown in heavy lines and the other as shown dotted in B of fig. 5.

21. As soon as S_5 closes, the bi-metal strip starts returning from the H (hot) contact of S_6 to the C (cold) contact. A path is then completed for the winding of S_4 through b of S_5 , c of S_6 and S_7 . The relay is self-locking as in the case of S_5 , an alternative path being shown dotted (C of fig. 5). When the relay S_4 closes, the winding of S_2 is energized through b of S_4 and S_7 , the contacts of S_2 move over as shown and relay S_3 becomes energized through b of S_2 and the moving contact of S_7 . The circuit for S_1 is broken at the same time, at b of S_2 .

22. This sequence of operations, A, B and C, fig. 5, takes place as soon as the supplies from the rectifier are available and the key is up. When the key is down, however, the conditions will be as shown at D in fig. 5. If S_8 is closed, the 12-volt rectified supply will be connected in series with the key across the winding of S_7 which becomes energized thus breaking the circuits for the relays S_6 , S_5 , S_4 and S_2 . Relay S_3 becomes energized through a of S_2 and the closed-circuit contact of S_7 , while relay S_1 becomes energized through b of S_2 and the moving contact of S_7 . The H.T. + to the amplifiers is made through c of S_2 and the aerial system through d , e , and f .

23. The period of delay, that is from the time the supplies are available and the bi-metal strip moves from C to H and back again to C (A, B, C, fig. 5), takes about 10 seconds. It will be seen therefore that if during transmission the key is raised for more than 10 seconds, the M/O circuit will be switched over to the stand-by position (C, fig. 5), and immediately the key is pressed the M/O circuit is switched back to the radiating or transmitting position D, fig. 5. The sequence of operation starts during each space in the signal, but is never completed unless the space period is more than 10 seconds.

CONSTRUCTIONAL DETAILS

Transmitter

24. Several views of the transmitter are given in figs. 1, 6, 8, 9, 11 and 12 and three bench wiring diagrams in figs. 7, 10 and 13. Referring to fig. 1, which is a view of the transmitter from the front, the various controls and instruments may be seen. The transmitter is built up in a duralumin frame-work with perforated metal panels. The overall dimensions are about 5 ft. 10 in. high, 2 ft. 6 in. wide, and 1 ft. 10 in. deep and its approximate weight is $4\frac{1}{2}$ cwt.

25. The switch (1) in the top right-hand corner has three positions engraved A, B and C. Its function is to include one or two condensers as desired in parallel with the amplifier tuning condenser, the control knob of which is at (2). The scale is divided into 100 divisions and a small window indicates the number of complete revolutions made. The neon lamp (3) indicates when the amplifier circuit is tuned. The neutralizing condenser control knob (4) with its scale (5) is mounted on the left.

26. Below the switch (1) is the aerial ammeter (30) reading 0 to 6 amps., and beneath it the aerial condenser tuning control (6). The output auto-transformer (L_3 , fig. 2) is seen at (7) and the master-oscillator tuning inductance may be seen at (8). In the bottom right-hand corner of the top section is the master-oscillator H.T. milliammeter (9) reading 0 to 300 mA. To the

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left of it is the control (10) for the space-tuning condenser. The master-oscillator tuning control (11) and fine tuning control (12) operate the variable condenser (C_1 , fig. 2). The dial is divided into 100 divisions and a window indicates the number of complete revolutions made. The neon lamp (13) indicates when the M/O is oscillating. The amplifier H.T. milliammeter (14) reading 0 to 500 mA is adjacent to the amplifier grid-bias control knob (15). Eight positions are provided on the latter and the dial is engraved accordingly.

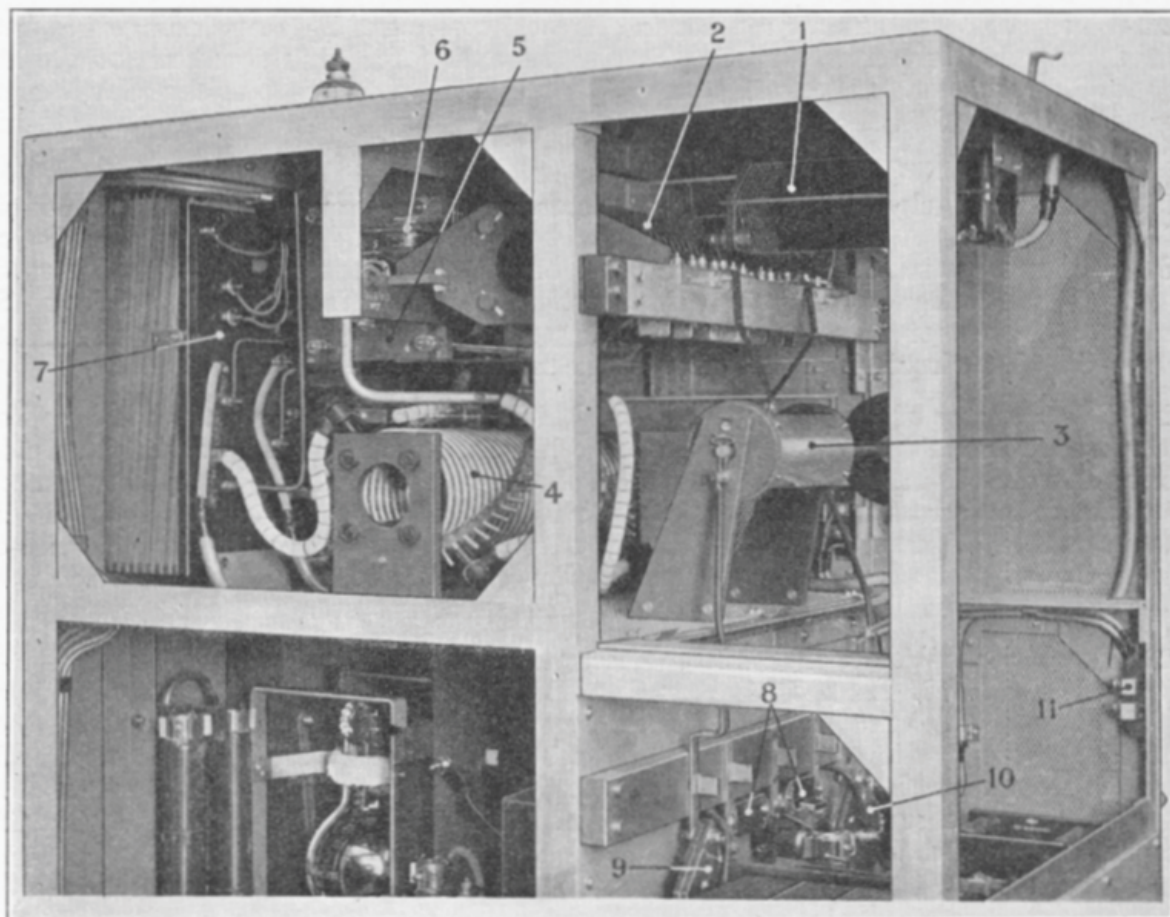
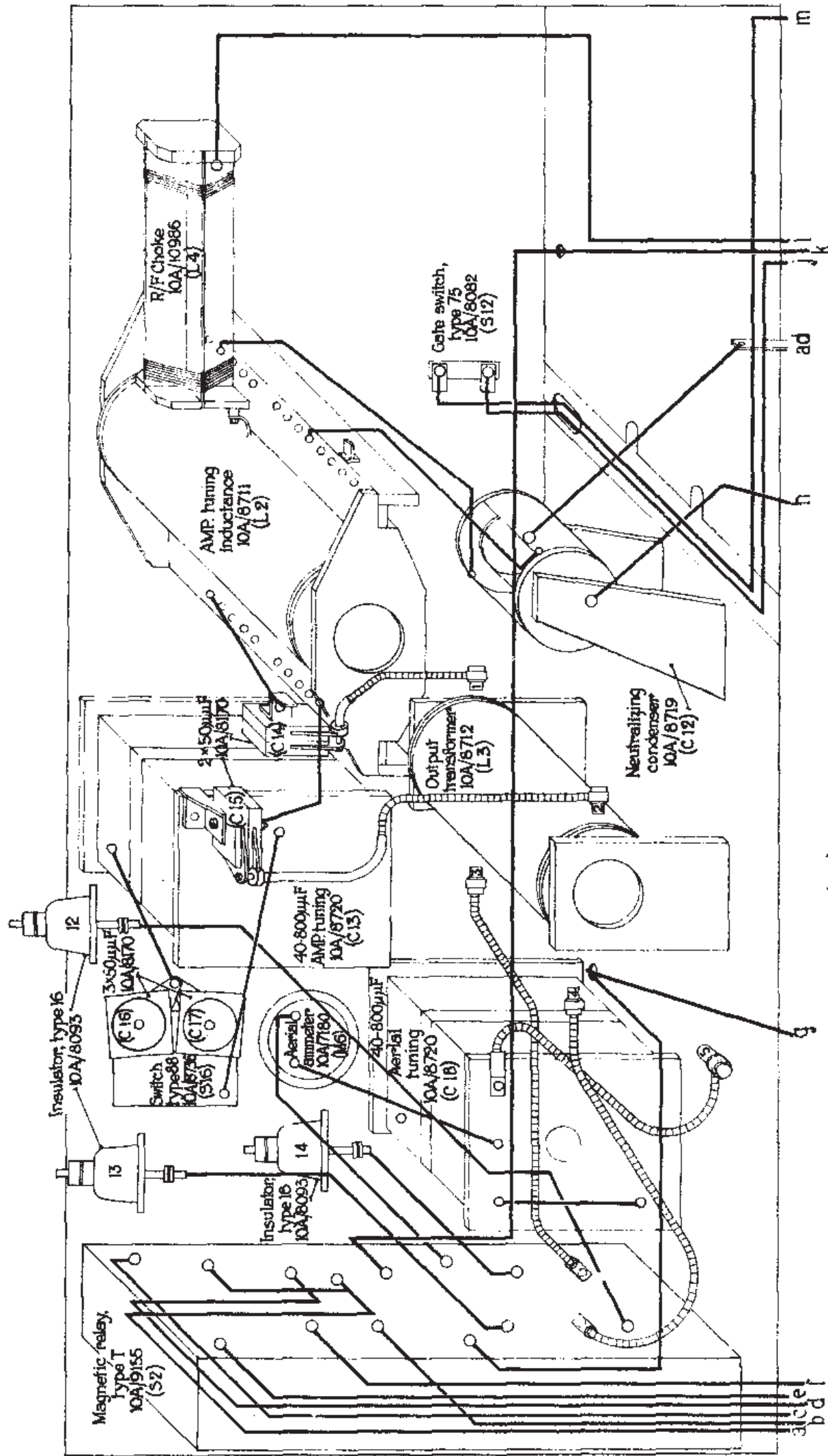


FIG. 6. Interior view of top section.

27. The smoothing unit components are housed behind the panel (16) on the front of which may be seen the M/O filament rheostat (17) and M/O filament voltmeter (18) reading 0 to 15 volts. The H.T. voltmeter (19) is in the centre of the panel and the tumbler switches (20) and (21) on either side of it are engraved KEY and FILAMENT respectively. Mounted on the left of the panel are the amplifier filament rheostat control (22) and the amplifier filament voltmeter (23) reading 0 to 15 volts.

28. The bottom section houses the rectifier components, the two switches (24) and (25) on the right are the H.T. and filament switch respectively. A pilot lamp shows through the window (26) when the main A.C. supply is switched on. Access to the rectifier valves is obtained through the door (27). The two valves (28) may be seen on the left.

29. An interior view of the top section of the transmitter is shown in fig. 6 and a bench wiring diagram of the same section in fig. 7. Referring to fig. 6, (1) is the R/F choke in the amplifier H.T. circuit. The amplifier tuning inductance (2) is on the left of the choke and the neutralizing condenser (3) is below it. The output auto-transformer (4) is mounted below the



NOTE : Annotations in parenthesis, for example (C12), refer to the corresponding annotations in Fig. 2

FIG. 7, WIRING DIAGRAM - TOP SECTION

amplifier tuning condenser (5). The two $50\ \mu\text{F}$ condensers (6) are represented by C_{15} in fig. 2. On the left of the illustration is seen the back of the panel (7) on which the relay (S_2 , fig. 2) is mounted. In the bottom right-hand corner can be seen the two 40-ohm resistances (8) connected across the amplifier filament circuit, and also the two R/F chokes (9) and (10) connected in the grid circuit of the amplifier valves. The gate switch (11) seen on the right is represented by S_{12} in fig. 2.

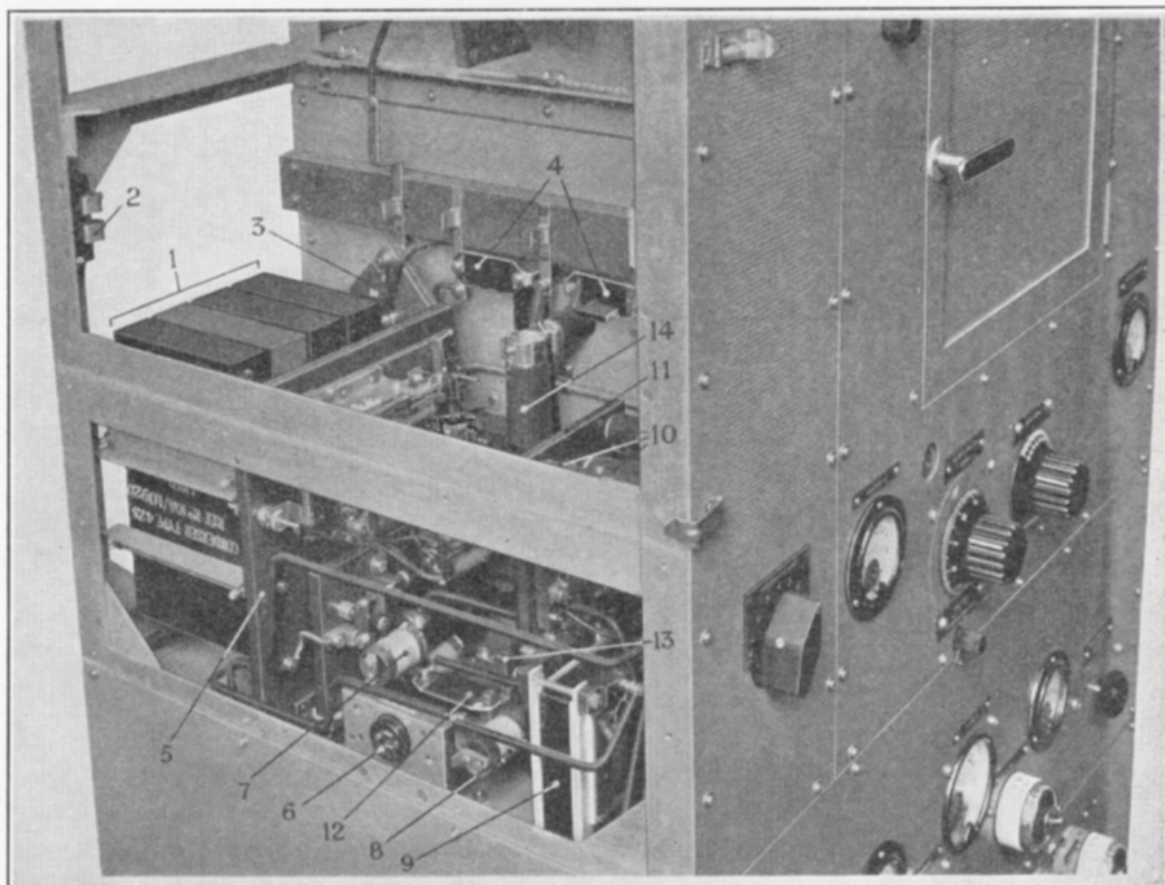


FIG. 8. Interior view of middle section, left-hand side.

30. Three interior views of the transmitter are given in figs. 8, 9 and 11, and a bench wiring diagram of the corresponding section in fig. 10. Referring to fig. 8, the three $1.5\ \mu\text{F}$ condensers (1) are connected up to form the condensers (C_{24} and C_{26} , fig. 2), the condenser nearest the frame being C_{26} and the other two being connected in parallel to form C_{24} . The type 428 condensers illustrated in these figures replace the existing type 256, and form the subject of a future modification. Above the condensers is another gate switch (2). One of the amplifier grid chokes (3) and the filament equalizing resistances (4) may be seen to the right of the condensers.

31. Mounted on the panel (5) are the relays, S_3 , S_4 , S_5 , S_6 and S_7 . To the right of the panel may be seen the 2-pole socket (6) into which the external amplifier is plugged. The two chokes (7) and (8) are connected in series with the primary of the input transformer (9). The panel (11) on which the resistances (10) for the amplifier grid-bias unit are mounted, can be seen above the transformer. One of the filament resistances (12) for the rectifier valve (V_4 , fig. 2) is mounted on the valve-holder (13). The resistance (14) has a value of 100,000 ohms and is the dropping resistance in series with the H.T. supply to the screen grids of the amplifier valves.

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32. In fig. 9, which is a rear view of the middle section, may be seen the two 20,000-ohm resistances (1) which are connected in parallel to form the anode feed resistance for the master-oscillator valve when coil No. 3 is being used. The resistance (2) has a value of 5,000 ohms and is connected with the choke (3) in the grid circuit of the M/O valve. The R/F choke (4) is in the H.T. feed of the M/O and is connected in series with the resistances (1). The M/O tuning inductance (5) is mounted above the M/O tuning condenser (6), and to the right of it is the relay (7) represented by S_1 in fig. 2.

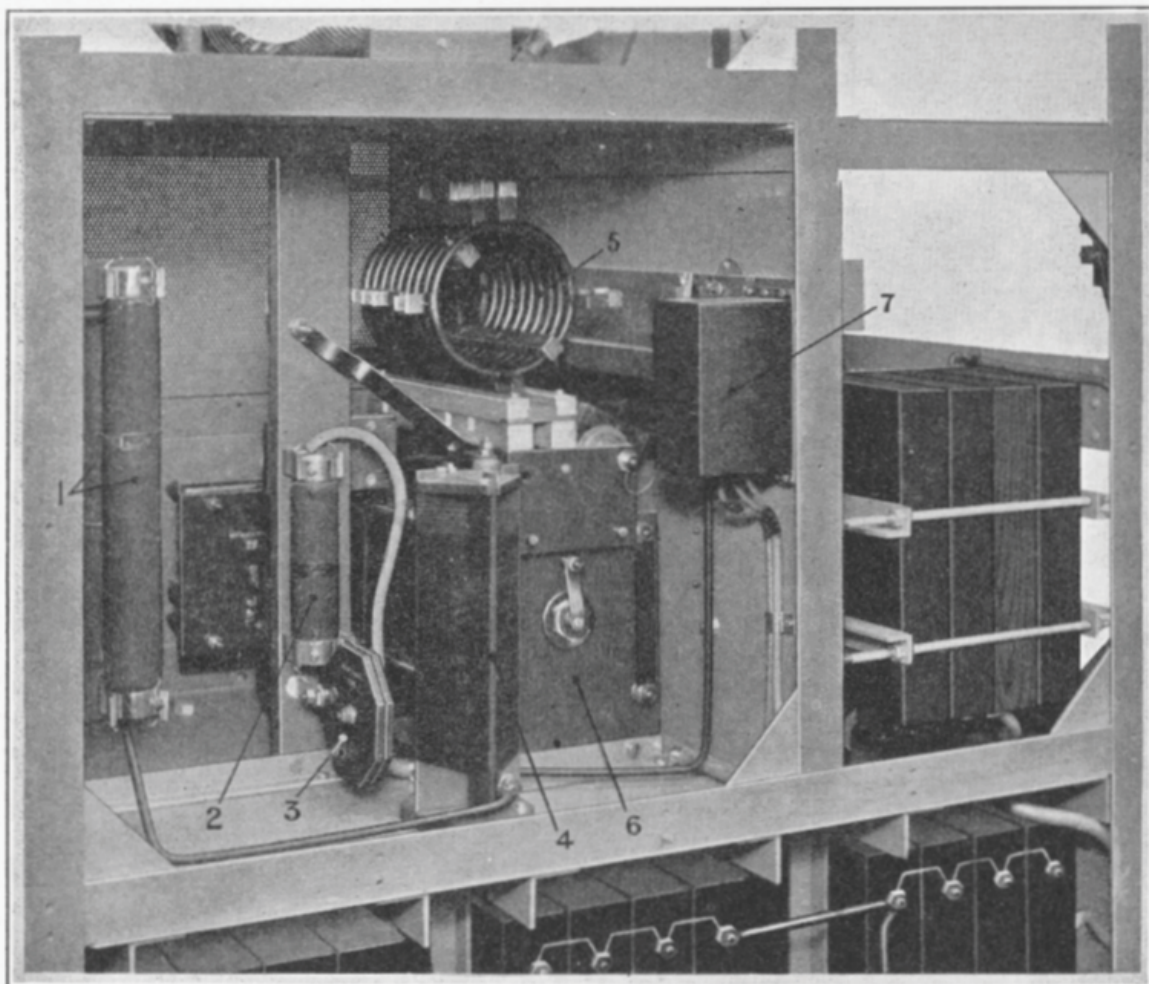


FIG. 9. Interior view of middle section from the rear.

33. Referring to fig. 11, which is an interior view of the transmitter from the right-hand side, the filament equalizing unit for the M/O valve can be seen in the foreground. It consists of the two $0.01 \mu\text{F}$ condensers (1) and the two 40-ohm resistances (2). Mounted near the condensers are two chokes (3) which are connected, one in each leg of the M/O filament circuit. They serve, in conjunction with the by-pass condensers of the filament equalizing unit, to prevent H/F feed-back from the M/O valve. The space-tuning condenser (4) is mounted below the neon lamp (5). The M/O, H.T. milliammeter (6) shunted by the $1 \mu\text{F}$ condenser (7) may be seen on the left.

34. In the upper portion of the illustration may be seen the aerial tuning condenser (8), aerial ammeter (9) and the relay (10); this relay is represented by S_2 in fig. 2. The three $50 \mu\text{F}$ condensers (11) and the three $50 \mu\text{F}$ condensers (12) form the condensers C_{16} and C_{17} represented in fig. 2. They are mounted on the switch (13), the blade of which can just be seen. The three aerial terminals (14), (15) and (16) seen above the transmitter correspond to the terminals 12, 13 and 14 respectively in fig. 2.

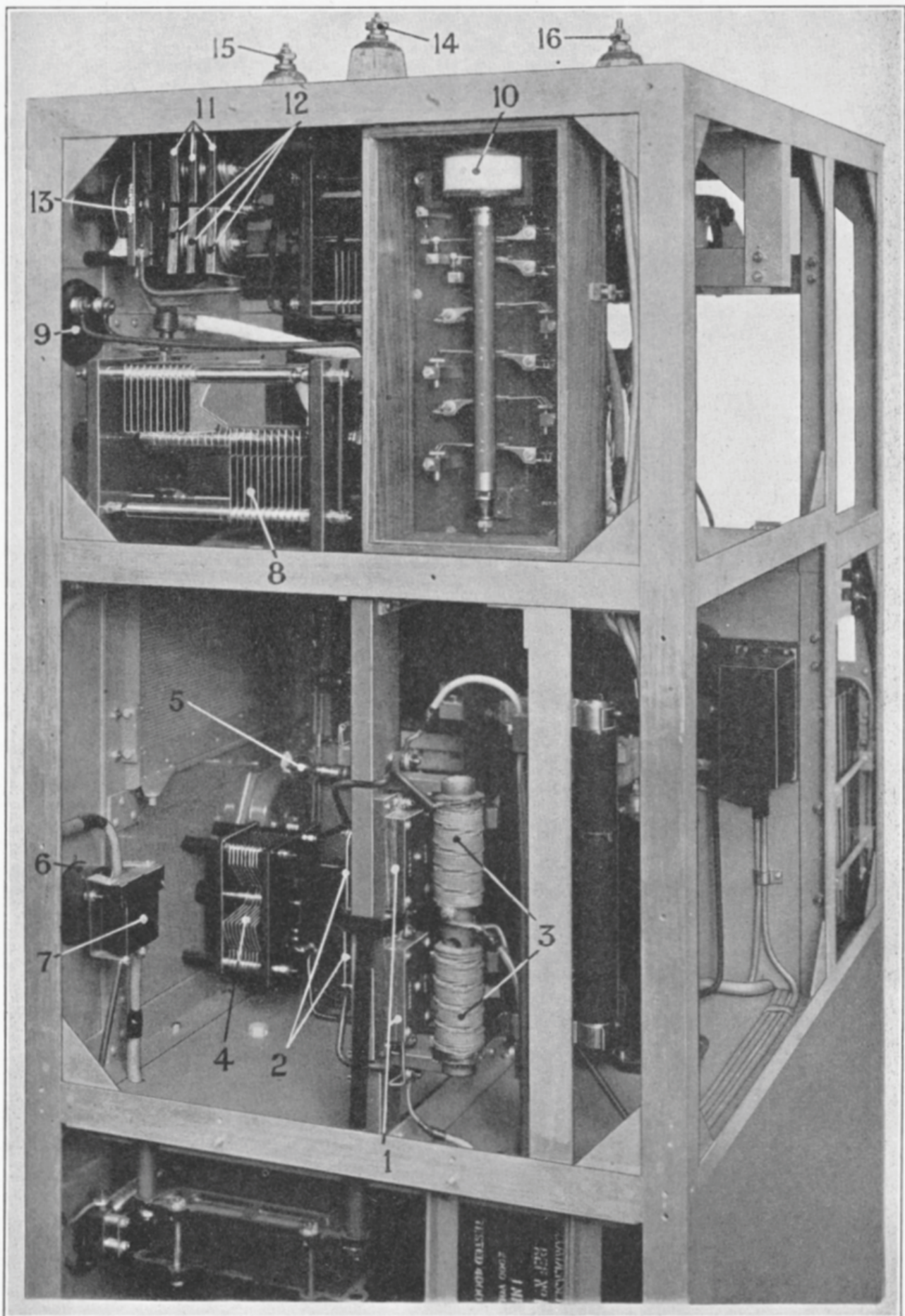


FIG. 11. Interior view of middle section, right-hand side.

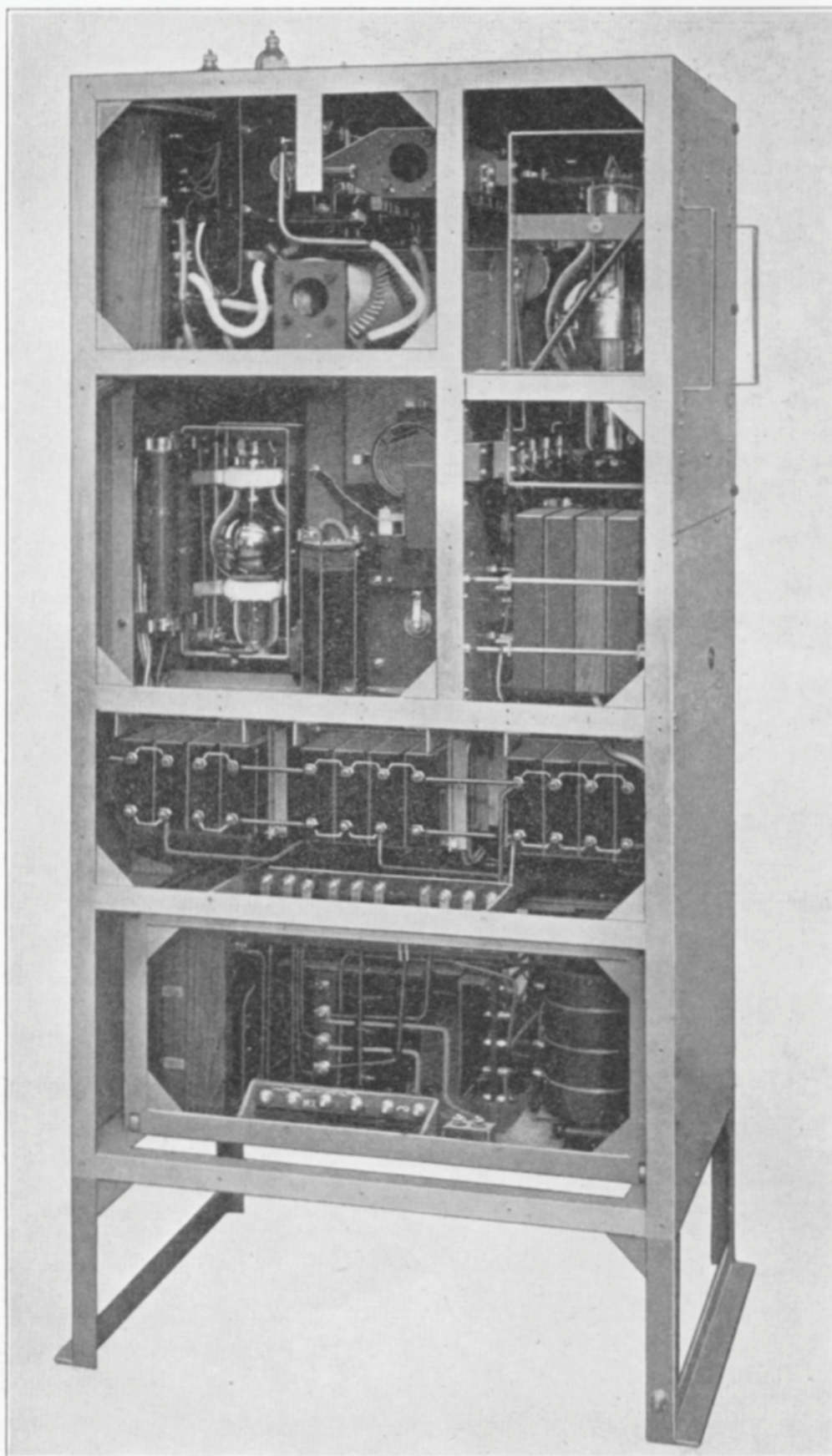


FIG. 12. Rear view of T.1087 with some of the panels removed.

35. A rear view of the transmitter with some of the panels removed is given in fig. 12. The illustration shows the valves in position and also the condensers and resistances which form the smoothing unit. A bench wiring diagram of this unit is given in fig. 13. The rectifier unit is situated below the smoothing unit. It may be withdrawn from the transmitter when desired, the framework being mounted on rollers, two of which may be seen. The rectifier unit and smoothing unit are described elsewhere in this publication.

Coils

36. In order to cover the whole frequency band of the transmitter, the M/O inductance consists of a set of three coils known as No. 1, No. 2 and No. 3. Coils Nos. 1 and 3 are each provided with a set of six contacts, while coil No. 2 is provided with four sets of six contacts, the four sets being engraved B, C, D and E, the lettering corresponding to the various ranges for which the coil may be used.

37. Each coil is a helix, wound on insulating material stiffening pieces. No. 1 coil consists of six turns of 20 s.w.g. copper tube $\frac{3}{8}$ in. dia. and covers the range 16,666 to 20,000 kc/s. the contacts being engraved A. No. 2 coil is wound with nine turns of 20 s.w.g. copper tubing, $\frac{3}{8}$ in. dia., and covers the range 3,000 to 18,750 kc/s. the four sets of contacts being engraved B, C, D and E. No. 3 coil covers the range 1,500 to 3,000 kc/s and is wound with sixteen turns of 20 s.w.g. copper tube, $\frac{1}{4}$ in. dia., the contacts being engraved F.

38. The terminal strip (29, fig. 1) is provided with a set of "C" contacts with which the blade contacts on the M/O coils engage. Access to this terminal strip is obtained through the front door of the transmitter. The right-hand strip is engraved with three lines A-B, C-D and E-F. To insert a coil, first slacken back the thumb-screw, insert the coil in the appropriate set of contacts, i.e. if the No. 2 coil is being used in position D, then the blades engraved D must be inserted in the contacts opposite the line engraved C-D. See that the coil is upright and tighten up the thumb-screw again. When inserting or withdrawing the coil, care should be taken to see that the spacing pieces are not damaged. Always insert or withdraw the coil in a vertical direction and avoid sideways movement.

39. A special stowage case has been provided for the three M/O coils and their associated resistances. The case and coils are illustrated in fig. 14. When the coils are stowed, No. 1 coil is placed over the support (1) so that the stiffening members (2) lie in the grooves of the support. The coil No. 2 goes over the support (3), the same remarks applying to the stiffening members (4). This is arranged so that the blade contacts will not be damaged. Coil No. 3 is inserted in the space (5) with the blade contacts near the panel (6). On the front of the No. 3 coil instructions are engraved stating which resistances should be used. The two resistances (7), when not in use are clipped into the lid of the case.

40. The amplifier inductance, which is a non-interchangeable unit, consists of five separate coils wound with $\frac{1}{4}$ in. dia. 20 s.w.g. copper tube. All five coils are mounted on a suitable support and form one long coil. The arrangement is as follows. A coil of nine turns is followed by one of two turns, then one of eight turns, then one of two turns and lastly one of nine turns giving thirty turns all told.

41. Twenty-six tapping points are brought out to knife contacts which engage with "C" contacts as desired. Looking at the coil from the front of the transmitter there are sixteen knife contacts on the left engraved H, G, F, E, D, C, B, A, A, B, C, D, E, F, G and H. On the right there are ten contacts engraved N, M, L, K, J, J, K, L, M and N. The contacts on the left are the anode taps, and those on the right are the closed circuit taps. H.T.+ is fed to the centre of the eight-turn coil.

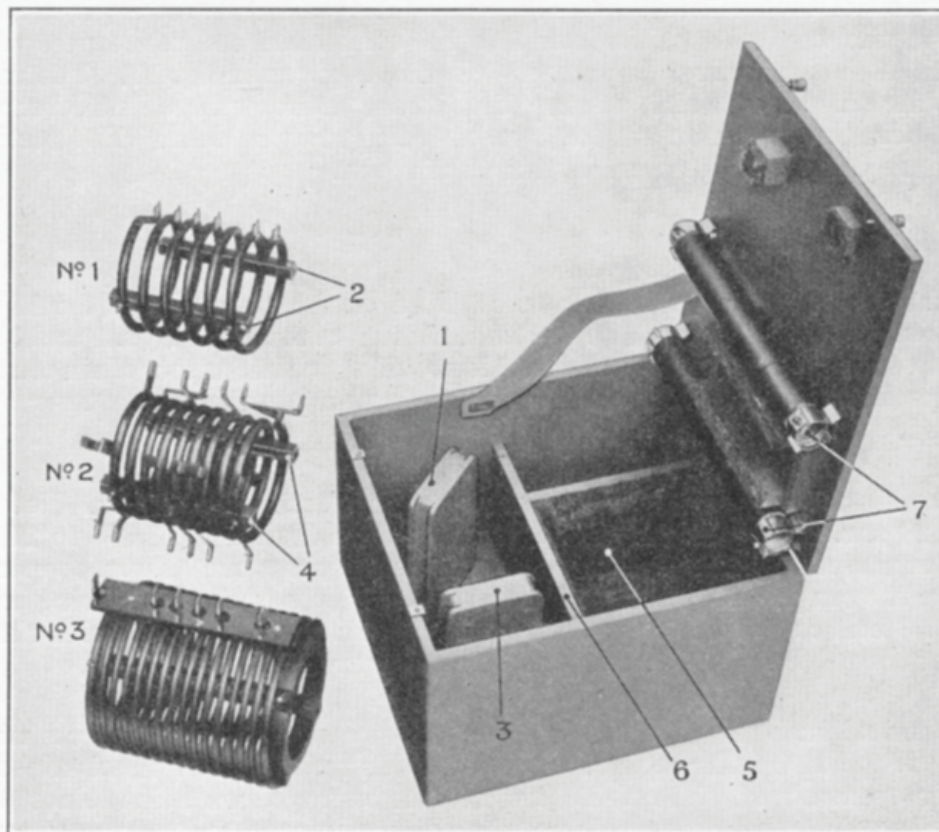


FIG. 14. Master-oscillator coils and case.

42. The auto-transformer output coil is wound with 30 turns of $\frac{3}{16}$ in. dia. 20 s.w.g. copper tube and every turn is tapped. A system of colouring and lettering is employed in order to facilitate connecting up. The taps are brought out to plugs with which sockets may be engaged. Viewing the coil from the front of the transmitter, on the right there are fourteen plugs on white bases with the letters P to A engraved in black, followed by fourteen plugs on black bases with the letters A to O engraved in white. The sockets (Nos. 3 and 4, fig. 7) can be engaged with any of the white base or black base plugs respectively. On the left-hand side of the coil there are fifteen plugs with red bases engraved with the letters Q to A in white, followed by 15 plugs with yellow bases and the letters A to Q engraved in black. The sockets numbered 1 and 2 (fig. 7) may be engaged with the red and yellow base plugs respectively. One further plug on a green base with the letter X engraved in red is positioned at the centre of the coil.

43. The sockets 1 and 2 are the input sockets and the sockets 3 and 4 the output sockets, when transmission lines are being used. The socket number 5 is used when the usual aerial system is employed. The tables at the end of this chapter show where the various sockets, should be engaged for the various frequencies desired (see also para. 77).

VALVES AND POWER SUPPLIES

44. Four valves are used in the T.1087, one as a master-oscillator, two valves in push-pull as the amplifiers and one as a rectifier to supply the grid-bias for the amplifiers. The mercury vapour valves used in the rectifier unit form part of this unit which is described elsewhere. The anode and filament voltages for the four valves in the transmitter are obtained from the rectifier unit.

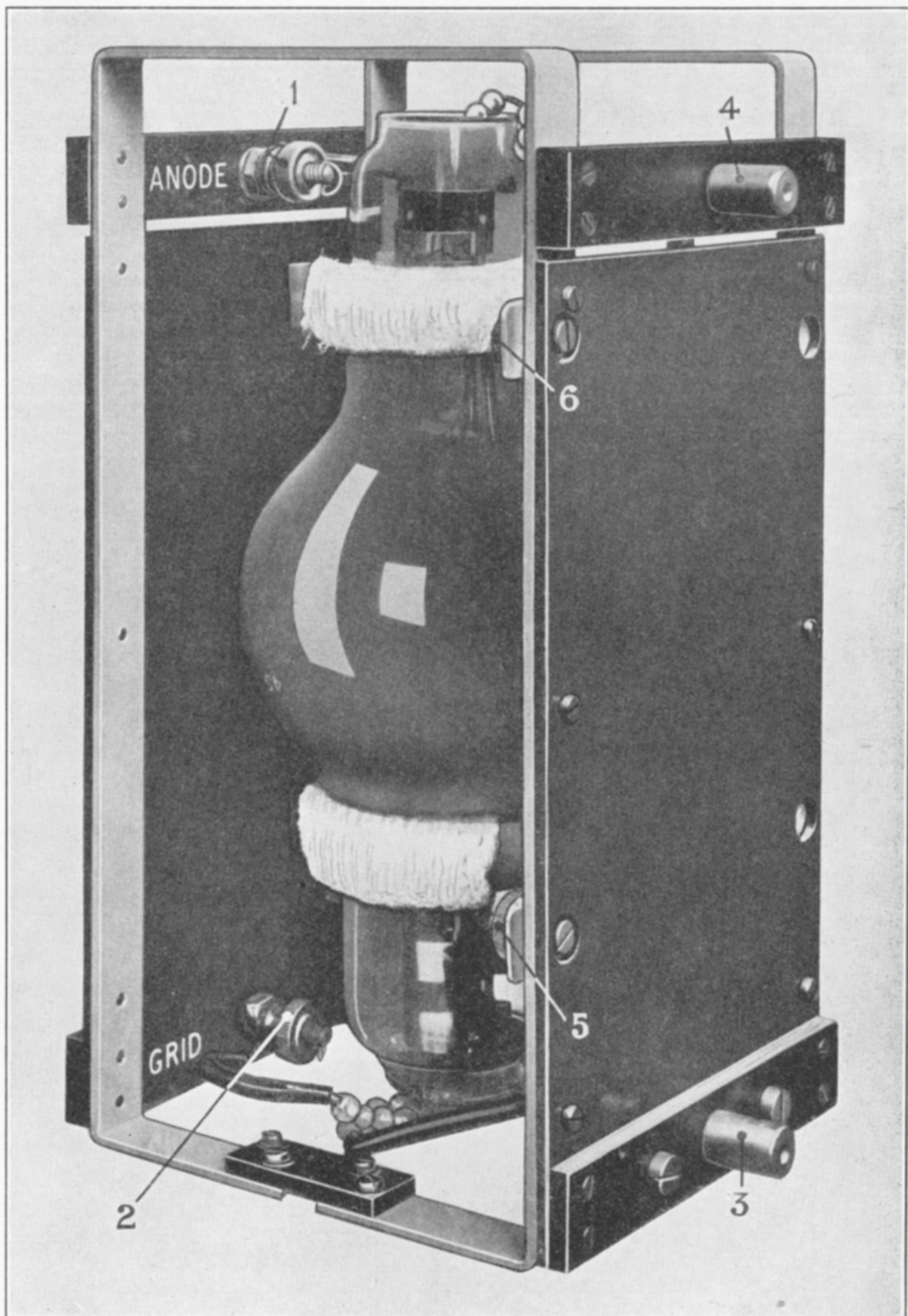


FIG. 15. Master-oscillator valve and valve-holder.

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45. The master-oscillator is a valve, type V.T.30, mounted in a special valve-holder. The valve-holder is removable and consists of a box-like structure formed by two strips of metal bent to form a rectangle and provided with two sides. Fig. 15 shows the manner in which the valve is mounted in its holder. Four terminals of the thumb-screw type are provided by means of which the valve is connected in circuit. The anode terminal (1) is on the left, the grid terminal (2) is beneath and the two filament terminals are mounted near each other on the right. The terminals are connected to four cylindrical metal connecting pieces, two of which (3) and (4) may be seen on the right. These two are connected to the valve filament terminals by metal strips. Two similar connectors are provided for the anode and grid.

46. To insert the valve in position, loosen the thumb-screws (5) and (6) on the two movable clips on the frame and displace the clips sufficiently to enable the valve to be inserted. Replace the clips and tighten the screws. Connect the valve leads to the appropriate terminals, keeping the leads as short as possible. To insert the valve-holder in the transmitter rest the top cylindrical contacts of the frame on the top "C" contacts of the supporting pillars inside the transmitter, access being obtained through the door in the top compartment. Push downwards on the frame until these contacts are well home. Rotate the frame about these contacts until the two bottom cylindrical contacts on the valve-holder engage the two bottom "C" contacts on the supporting pillars and push them well home.

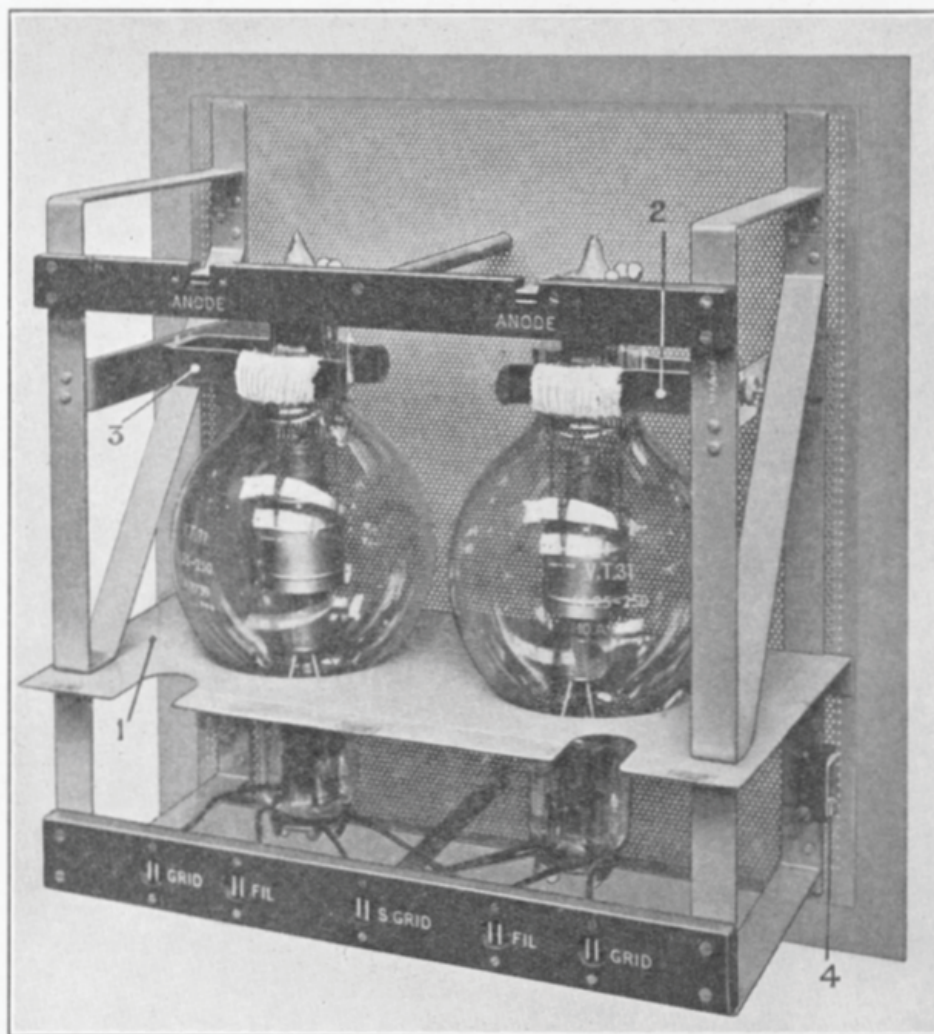


FIG. 16. Amplifier valves mounted on panel.

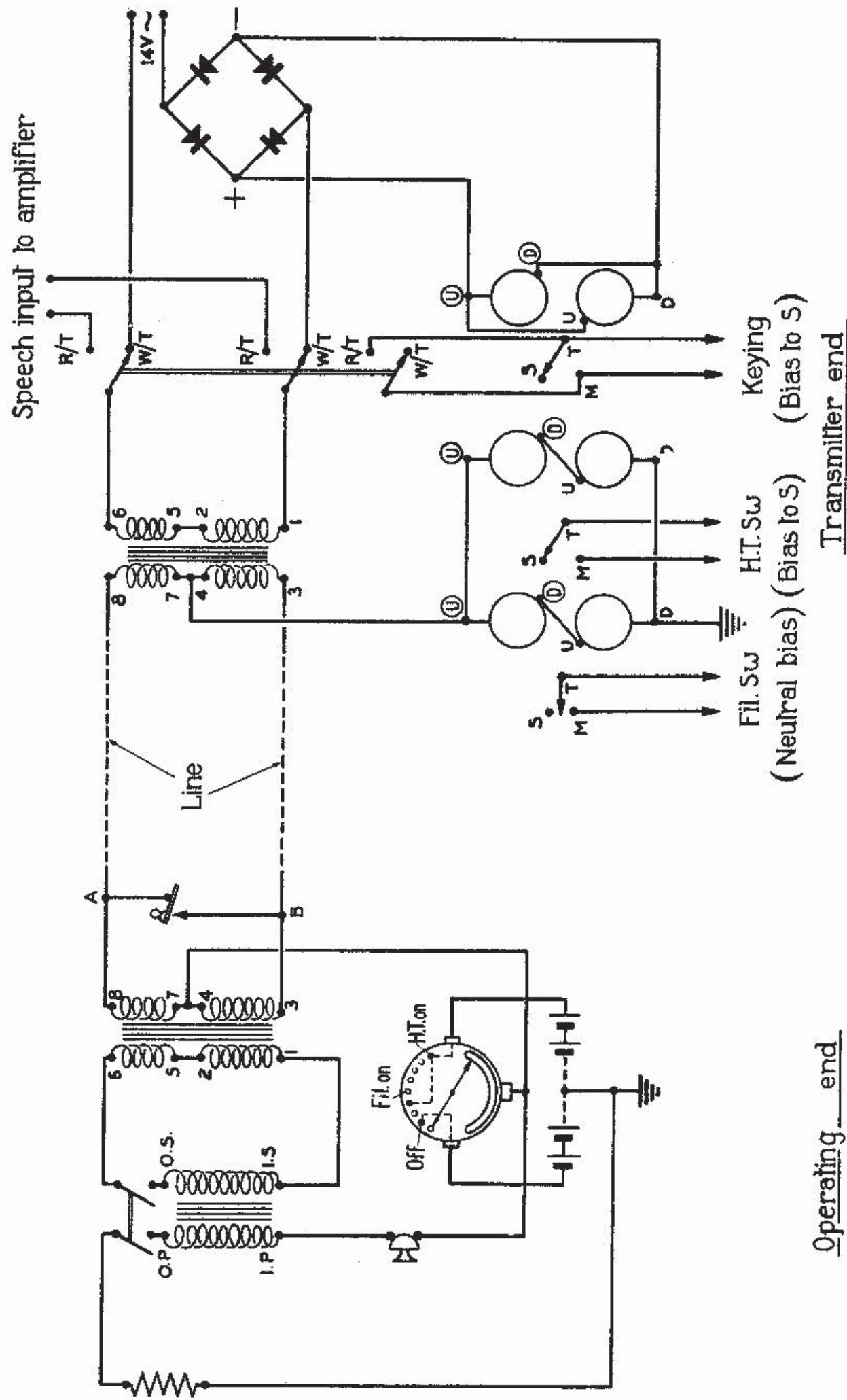


FIG. 18. SCHEMATIC OF REMOTE CONTROL

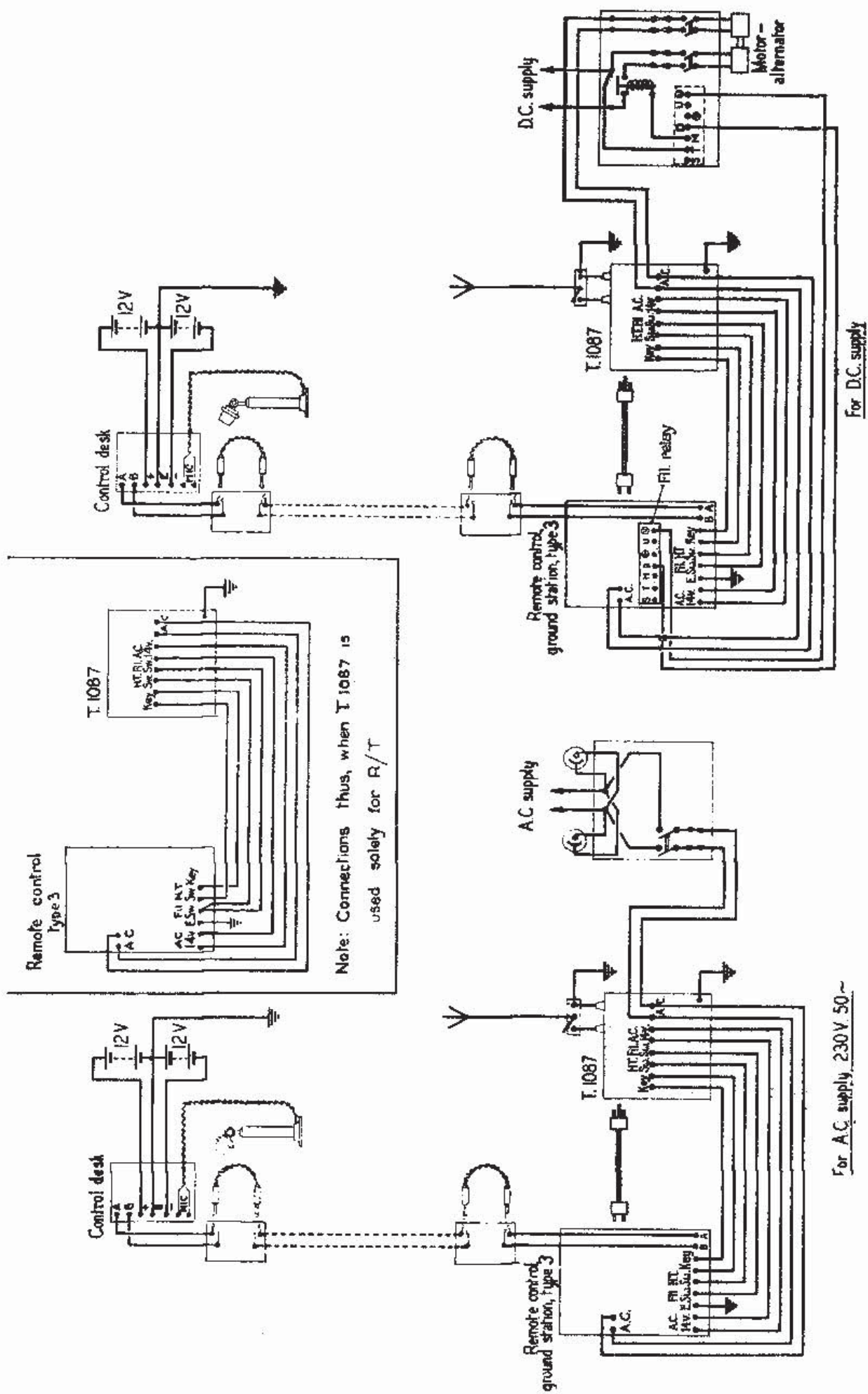


FIG.19, TYPICAL INSTALLATION FOR REMOTE CONTROL

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47. Two V.T.31 valves are used for the amplifiers. The valves are mounted in a removable frame, and the various electrodes are connected to "C" contacts which engage blade contacts on the transmitter when the frame is in position. The frame is secured to a perforated metal panel which is held in position on the transmitter by seven spring clips.

48. Referring to fig. 16, it will be seen that the anodes of the valves are brought out to two "C" contacts supported in a strip of insulating material and appropriately engraved. Since the screen-grids of the valves are connected together, one "C" contact is provided. The remaining four "C" contacts on the bottom strip are self-explanatory.

49. To insert the valves in position, slacken the thumb-screws on the valve clips. Insert the filament ends of the valves through the holes provided in the screening panel (1) and rest them on the pads provided. Place the clips (2) and (3) on the tops of the valves and secure them in position by means of the thumb-screws. Connect the valve leads to the appropriate terminals, keeping the leads as short as possible. Hold the frame by means of the two handles provided and push the panel well home so that the "C" contacts engage properly with the blade contacts on the transmitter. Make sure that the blade contact (4) engages with the "C" contacts (2, fig. 8).

50. The rectifier valve which is a type V.T.25 valve is inserted in an ordinary valve-holder type G, wired up in the usual manner. The filament voltage required for the M/O valve is 12.5 volts, the filament voltage for the amplifiers is 11.25 volts, and for the rectifier valve a filament voltage of 8 volts is required.

INSTALLATION

51. The transmitter can be operated locally or by means of remote controls. When remote operation is required, remote controls, types 2 or 3, are employed. The usual procedure is to operate the transmitter remotely, but should the remote cable break down, or for any reason remote operation become impossible, then the transmitter may be operated locally. For R/T or M.C.W., the amplifier portion of remote controls, type 3, is essential. As the remote control unit is always installed near the transmitter, both local and/or remote operation is possible.

With local control

52. A typical diagram for local control is given in fig. 17. Both D.C. and A.C. systems are shown but when D.C. is used, the supply is connected to a motor-alternator to produce A.C. which is used to operate the transmitter. The D.C. mains must not be connected directly to the transmitter else the transformer for the biasing valve will be ruined. The portion shown dotted represents the amplifier A.1104 and its connections. The A.1104 is a portion of remote controls, type 3, and it is essential to this transmitter when R/T or M.C.W. is desired.

With remote control

53. When the transmitter is arranged for remote control, the method of wiring shown in the simplified circuit in fig. 18, will normally be used. In this method one pair of leads between the operating station and the transmitting station is used for each transmitter. Through this pair and an earth connection, the filament and H.T. relays are operated, the transmitter is keyed and R/T modulation is performed. For the latter purpose the pair is connected at each end to one winding of a repeating coil.

54. The relays controlling the filament and H.T. supply to the transmitter are operated by direct current derived from a battery at the operations end of the line. The battery is connected between the centre point of the line winding of the repeating coil at the operations end and earth, and the relays are connected in parallel between the centre point of the line winding of the repeating coil at the transmitter end and earth. The direct current to operate the relays thus divides equally in the two lines and there will be equal currents in opposite directions in the half windings of the repeating coil, and the core will not, therefore, be magnetized.

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55. A typical installation for remote controls is shown in fig. 19. The circuit, shown in fig. 18 is incorporated in the controlling desk at the operations end, and a circuit diagram of this apparatus is given in fig. 20. A receiver will normally be fitted up on the same desk.

56. In an installation using a D.C. supply, a further relay with neutral bias, is connected in parallel with the filament relay at the transmitter end to operate the starter of the motor-alternator, as shown in fig. 19. Thus when the switch, type 44, at the operations end is placed in the central position (engraved GEN. RUNNING), the motor-alternator is started. When the switch is used in conjunction with A.C. mains, the engraving should be interpreted as "filaments on". For a description of and the manner in which Remote Controls should be used, reference should be made to the appropriate section of this publication.

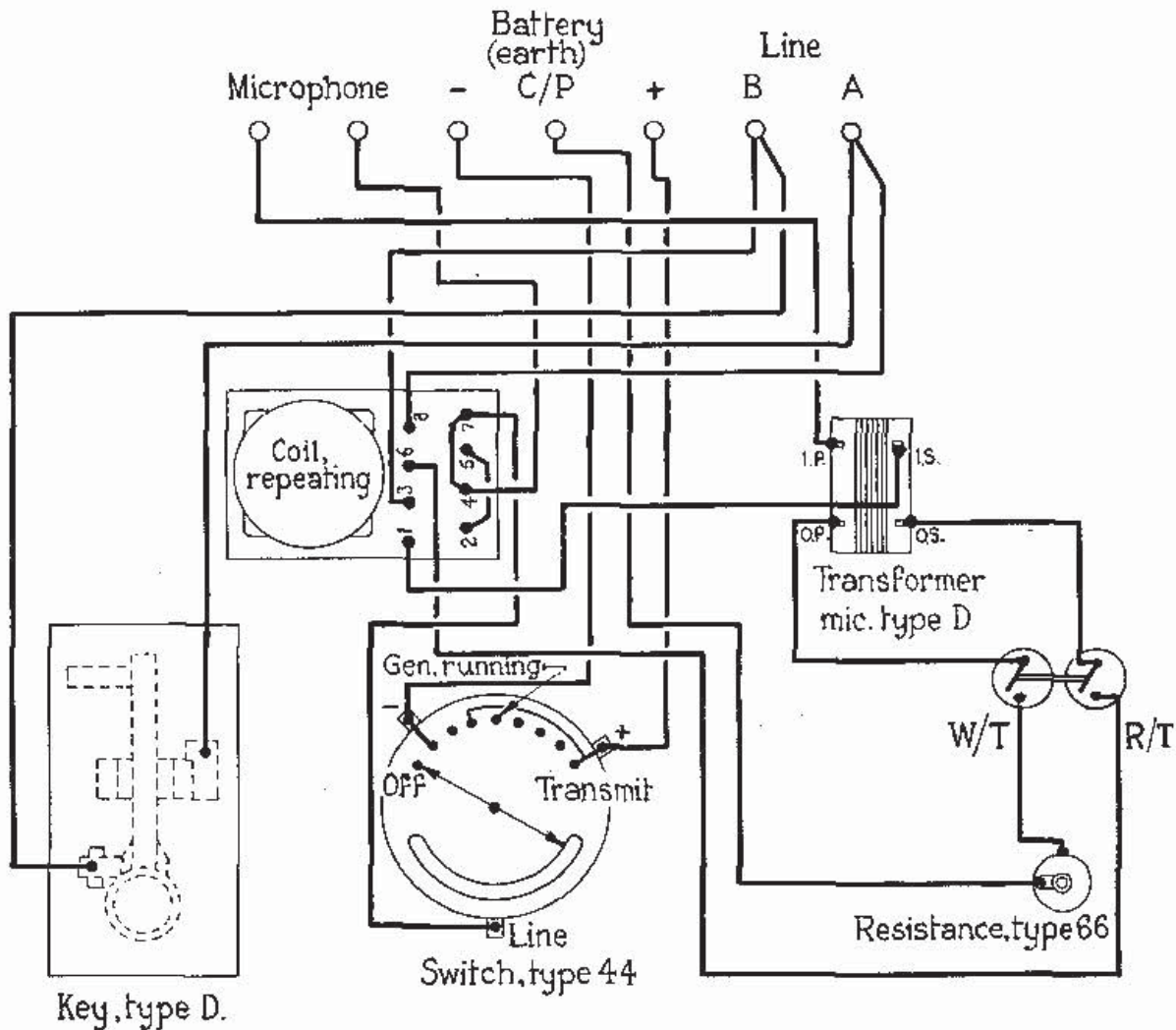


FIG. 20. Circuit diagram of apparatus on Control desk.

OPERATION

Preparation for tuning

57. Before the transmitter is ready for tuning, certain preliminary operations must be performed. Insert the M/O valve as described in para. 46; insert the amplifier valves as described in para. 49. Insert the neon lamps—a lamp has to be inserted in each of the positions (3) and (13) (fig. 1). Each lamp screws into a holder incorporating a cylindrical condenser and mounted by its single contact screw. The holder may be removed after loosening the nut on the contact screw, the neon lamp screwed in, and the holder replaced.

58. Insert the biasing rectifier valve in its holder insert the two V.U.29 power rectifying valves in their screwed sockets. Insert the pilot lamp and the fuses in the rectifier panel. There are four of these fuses and each one should carry two strands of 33 s.w.g. tin wire. Make sure that all switches are off, and that bias is on stud 8.

To set up the transmitter for C.W. (Local Control)

59. Connect a 230-V. 50 cycle A.C. supply to the two terminals engraved accordingly at the bottom of the transmitter. Connect the H.T. and filament switch terminals (i.e. the second, third and fourth terminals counting from the left) together by a piece of 16 s.w.g. tinned copper wire. Connect a morse key across the terminals engraved KEY, now close the main A.C. switch, and the pilot lamp in the rectifier should light up.

60. In the following paragraphs all annotational references refer to fig. 1. Close the rectifier filament switch (25) and the delay action referred to in para. 17 starts. Close the transmitter valve filament switch (21), and check the filament voltage on the M/O and Amplifier valves. The M/O filament volts may be read on (18) and should be adjusted by the control (17) to read 12.5 volts. The amplifier filament volts may be read on (23) and should be adjusted by the control (22) to read 11.25 volts.

61. Place the rectifier H.T. switch on stud 1, close the door (27) and switch on the rectifier H.T. by means of the switch (24). The H.T. volts read on (19) should be about 1,900. This is the "no-load" H.T. voltage. When the M/O is switched on to the space-tuning frequency, the voltage will drop to about 1,700 volts.

62. Switch on the key switch (20). This switch is in series with the key which should be up. Switch off H.T. at (24) and tap the key, now insert the appropriate M/O coil, set the various tappings, and adjust the controls by reference to the Tables. Close the rectifier H.T. switch (24) and, after the necessary time delay has occurred, the relays in the transmitter will operate to transfer the M/O circuit to the space-tuning frequency as described in para. 19 *et seq.* The neon lamp (13) should now glow and a reading of approximately 100 mA should be obtained on the M/O H.T. milliammeter (9). The master-oscillator should now be oscillating on the space-tuning frequency, which should be adjusted by the control (10) so as to give a frequency which will not cause local interference.

63. The amplifier stage will now have to be tuned. Off-set the neutralizing condenser to 0° or 180° , set the grid-bias to stud 8. Next the key should be locked in the down position which results in the M/O circuit being transferred immediately to the frequency at which radiation is desired. The neon lamp (3) should glow, due to a transference of R/F volts from the M/O *via* the condensers C_{5-10} (fig. 2), indicating that the amplifier is tuned to the M/O frequency but un-neutralized.

64. It will then be necessary to neutralize the amplifier. The correct neutralizing position may be obtained in the following manner. Assume that (5) is set at 180° as described in the previous paragraph. Rotate the control (4) until the lamp (3) goes out and note the reading on (5), say 110° . Carry on rotating (4) until 0° is reached when (3) will be glowing again. Now rotate (4) in the opposite direction and note the reading of (5) when the lamp (3) goes out again, say 70° . Then the correct neutralizing position is mid-way between 70° and 110° , which is 90° . Set (5) to this figure and the amplifier is now correctly tuned, neutralized and ready for operation.

65. The bias may now be reduced with safety to position O, and the input shown on the milliammeter (14) should be of the order of 170 mA with the H.T. on stud 1. The aerial ammeter should also show some reading. Finally the aerial should be tuned in conjunction with the amplifiers to give maximum output. Although the transmitter will now radiate C.W., it is not necessarily operating at its maximum efficiency. In order to obtain this condition it will be necessary to proceed as set out in paras. 77 *et seq.*

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66. The frequency should be checked at this stage and the transmitter adjusted if necessary. The wavemeter W.1081 may be used for any frequency within its range, or wavemeter W.39 or W.39A may be used with harmonics. The frequency of the master-oscillator should be adjusted by means of the fine tuning knob (4), exactly to what is required. One complete turn of this knob corresponds to approximately two divisions of the main condenser. For the use of Crystal Monitor, type 1 (*see paras. 90 et seq.*).

To set up the transmitter for R/T or M.C.W. (Local Control)

67. For local R/T or M.C.W. a portion of Remote Controls, type 3, will have to be used. The necessary portions are Panel, Amplifier, (Stores Ref. 10A/9589) and Panel, Local Control, (Stores Ref. 10A/9590). Although Panel, Remote Control, type A (Stores Ref. 10A/9588) is part of Remote Controls, type 3, it is not essential for this purpose. Panel, amplifier is connected to the transmitter by a screened flexible cable terminating at each end in a three-pin plug. One plug is inserted in the output socket of A.1104 and the other plug is inserted in the socket (6, fig. 8) on the side of the transmitter. See that the oscillator panel and amplifier panel are connected together by the double-ended telephone plug lead on the side of the unit, and by means of the double-ended six-pole plug and lead at the back of the unit. The A.C. mains from the transmitter are connected to the terminals engraved A.C. MAINS on the remote control unit. A microphone is plugged into the appropriate socket on the local control panel. The terminals at the back of the transmitter remain connected as for local C.W.

R/T (Local control)

68. The transmitter is set up and tuned in exactly the same manner as for local C.W., except that the bias for the transmitter amplifier valves will require some further adjustment. To do this the reading of the aerial ammeter (30) should be noted and the amplifier bias switch should then be adjusted to the setting which will reduce the aerial current by approximately 50 per cent. This is the best setting for R/T. If the aerial current is too small to allow of accurate tuning, a thermo-ammeter (0 to 2.5 amp.) should be connected in series with the aerial.

69. Now switch on the A.C. switch on the amplifier panel and move the selector switch on the local control panel to the "local microphone" position. Speech may now be radiated, but the volume control on the remote control unit will have to be adjusted to give the necessary "audio volts" in order to modulate the transmitter. The best position for audio volts is a combined setting of the attenuator and volume controls, such that the reading of the milli-ammeter on the amplifier panel remains at about 120 mA without excessive fluctuation when speech is radiated. As an indication of the percentage modulation, an increase of $22\frac{1}{2}$ per cent. in the steady aerial current represents a modulation of 100 per cent.

M.C.W. (Local Control)

70. Set up and tune the transmitter as before, and set the bias as for R/T. Place the selector switch on the local control panel to the "oscillator position" and connect the oscillator panel to the amplifier panel by means of the screening cable terminating at each end in a telephone plug. Adjust the volume control and attenuator to give the necessary audio volts for correct modulation and then key.

To set up the transmitter for C.W. (Remote Control)

71. For any remote control operation with this transmitter, Remote Controls, type 3 or type 2, may be used. The 230-V. 50 cycle A.C. mains should be connected to the A.C. terminals on the transmitter, and also to the left-hand pair of terminals on the upper terminal strip on the Remote Control unit. Connect the key, filament switch, and H.T. switch terminals on the transmitter to the corresponding terminals on the Remote Controls. Care should be taken to ensure that the correct key terminals are connected up. One key terminal on the transmitter is common to H.T. switch and filament switch and this terminal should be connected to the corresponding one of the Remote Control unit. Connect the 14-V. terminals on the transmitter

to the 14-V. terminals on the R/C unit. Units have been instructed to modify the T.1087 to incorporate these 14-V. terminals which should be connected to the terminals engraved 0 and 14 on the filament transformer in the transmitter rectifier unit (*see* figs. 2 and 12). The incoming lines A and B from the operations block must be connected to the terminals A and B on the R/C unit. The terminal engraved E should be connected to the transmitter earth.

72. It will now be possible to operate the transmitter both locally and remotely. For remote operation, however, it is first necessary to set up and tune the transmitter locally. The two filament, key and H.T. switches on the transmitter are put on. The transmitter may now be set up and tuned, using the switches and key on the R/C unit for the necessary operations, the procedure being exactly the same as for local C.W. When the transmitter has been set up and tuned all the switches, both on the transmitter and on the R/C unit are left on, with the exception of the H.T. switch on the R/C unit, because it is desirable, when using this transmitter, that the filaments should be left on continually. The ganged switches on the R/C unit are put to W/T and the transmitter may then be operated remotely on C.W., all the necessary switching and keying being done at the operations end.

To set up the transmitter for M.C.W. (Remote Control)

73. The transmitter and R/C unit are connected up as before and the transmitter is set up and tuned in the same manner as for remote C.W. Before M.C.W. can be radiated however, the amplifier portion of the R/C unit must be connected to the transmitter. The ganged switches must be in the W/T position, and the selector switch must be set to the "oscillator" position. The volume control must be adjusted as for local M.C.W.

To set up the transmitter for R/T (Remote Control)

74. In this case the connections between the R/C unit and the transmitter are somewhat different. Since the ganged switches on the R/C unit short-circuit the key in the R/T position, the M/O never transfers to the space-tuning frequency, because in effect the key is never up. To overcome this difficulty the transmitter should be connected up in the manner shown in the insert on fig. 19. Close the filament and H.T. switches on the transmitter. Set up and tune the transmitter as for local R/T using the filament and H.T. switches on the R/C unit as desired.

75. When the transmitter is ready, plug in the screened cable, into the socket (6, fig. 8) and also into the R/C unit, switch on the A.C. switch on the amplifier panel, place the ganged switches in the R/T position, and the selector switch in the "Local microphone" position, plug in the local microphone, and adjust the volume control on the amplifier panel for normal speech at the transmitter; bias adjustment will be the same as for local R/T. Leave all switches on except the H.T. switch on the R/C unit. Owing to the resistance of the lines A and B and the consequent loss of speech input to the R/C unit, it may be necessary to make a further adjustment to the volume control when remote R/T is being used.

76. After the transmitter has been set up and adjusted satisfactorily by the local operator (bias adjustment and volume control), the selector switch should be moved to the "600 ohm input" position. The remote operator should now speak into his microphone while the operator at the transmitter end should watch the milliammeter and adjust the volume control in order to give the necessary audio volts. This further adjustment is not necessary on remote M.C.W., since the oscillations are generated at the transmitter end and are therefore not influenced by the extra resistance of the lines A and B as in the case of remote R/T.

Method of improving transmitter output

77. It should be borne in mind, that if the transmitter has been set up to the Tables, the most favourable operating conditions may not necessarily be obtained. The transmitter will, however, radiate and may be used on these settings. When time permits, units should ascertain for themselves which settings give the best performance and they should make a note of these settings for future reference. The tables are merely given as a guide, and are correct for a particular transmitter, but since transmitters may vary slightly depending upon the source of manufacture and varying impedance of the aerial system, the figures may not apply to every transmitter

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for the most efficient operation. In the following paragraphs a method is given of the manner in which a transmitter should be set up, first to the Tables and then adjusted if necessary to improve the output.

78. The reason for the difference between the settings shown in the Tables and those which may be obtained on a T.1087 in Service is due to the following points. The figures and settings shown in the Tables were obtained on a particular transmitter using the correct aerial, namely a 54 ft. 6 in. wire cage outside the building and 5 ft. of lead-in to the aerial terminal. The earth system used was a good radial earth with short connections to the transmitter and there were no other aerial systems in the vicinity.

79. The valve impedance of the two V.T.31 output valves used in the transmitter is of the order of 4,000 ohms and the impedance of a good aerial-earth system as set out in the previous paragraph is approximately 70 ohms. It should be noted here that any alteration in the total length of aerial, or the resistance of the "earth" due to corrosion or dry ground, etc., or the proximity of other aerial systems or power absorbing objects, or the alteration to the height of the aerial will seriously alter the impedance of the aerial circuit. In order to provide for slight variations in these impedances, the output transformer is provided with several tapping points. The combination that should be used will depend on the particular installation. It will be seen therefore, that, unless the conditions are identical with those stated above, the settings, in practice, will differ from those given in the Tables.

80. The following method of improving the transmitter output matching is given as a guide only, and Units should adopt a similar method to obtain the best matching conditions. The result to be aimed at is an increased working efficiency of the transmitter, i.e. the ratio between the output watts and the input watts expressed as a percentage. The output watts are C^2R , where C is the aerial current and R is the resistance of the aerial-earth circuit, the input watts being the product of the amplifier D.C. volts and D.C. milliamps.

81. The output transformer is provided with several tapping points and four plugs are provided to engage these points. When making these adjustments to obtain maximum efficiency, it is desirable to move the plugs one at a time so that any increase or decrease of efficiency may be observed. If two or more plugs are moved at the same time, it will not be clear which one is responsible for the increase or decrease as the case may be.

82. Insert a small 0 to 2.5 amp. thermo-ammeter between the aerial lead-in and the aerial terminal of the transmitter. Before making any alteration inside the transmitter, make a note of the amplifier D.C. volts, D.C. milliamps. and the R/F aerial current. Then, being careful to switch off the H.T. before opening the transmitter, move plug No. 1 one tap either backwards or forwards. It is important to remember in which direction the move has been made. Now switch on the H.T. and re-tune the amplifier for maximum output. The series aerial tuning condenser must be mentioned at this stage as it plays an important part in the tuning of the T.1087. The aerial circuit of this transmitter is fairly tightly coupled to the amplifier circuit, therefore any change of amplifier tuning may affect the aerial tuning. It is therefore desirable that the amplifier tuning condenser and the aerial tuning condenser should be adjusted *together* in order to give maximum aerial output.

83. Having moved plug 1 and re-tuned, it may be noticed that the input milliamps. have decreased while the R/F output has remained the same or even increased. This indicates a definite increase in efficiency and furthermore that the plug has been moved in the right direction. Now move plug No. 2 in a similar manner. The direction in which it should be moved is important. If plug No. 1 has been moved towards the centre of the coil, then plug No. 2 should be moved towards the centre of the coil. Continue moving plugs Nos. 1 and 2 until a position is found where the output efficiency is a maximum. Now leaving plugs 1 and 2 in their new positions, move plugs 3 and 5 separately till the maximum output efficiency is obtained. A further adjustment may be made at this stage. Move plugs 1 and 2 *together* either backwards or forwards, moving each plug the same number of turns and, after finding the best position, move plugs 3 and 5 *together* in a similar manner.

84. The point to bear in mind, while moving these plugs is that a balance is to be aimed at between the two V.T.31 valves. The amplifier stage is a push-pull circuit which has been designed for mechanical and electrical symmetry. Therefore, if an unbalanced aerial circuit is coupled to the amplifier stage, the symmetry is upset and it may be possible for one V.T.31 valve to be overrun. This overrunning may be indicated by the anode of the valve heating up and glowing red. This unbalance can come about as the result of the position of plugs 1, 2, 3 and 5, and it is therefore necessary when making adjustments to these plugs, to observe the effect on the valve anodes and to endeavour to keep them as nearly equal in colour as possible.

85. If the power radiated in these circumstances is adequate, there is no necessity to increase the H.T. tap. Stud 2 or 3 need only be used where greater range is desired, or where the signal to noise ratio may be improved, as for example overcoming local interference. To change the H.T. stud, switch off H.T., set the bias back to 8, move the H.T. switch to stud 2 or 3, switch on H.T. and then reduce bias to 0. It may be necessary to re-tune the amplifier and aerial slightly to give maximum aerial current reading. It may also be necessary to re-adjust the filament volts on the master-oscillator and amplifier: controls (18) and (23) respectively. A check on the frequency is again necessary.

86. Although this tap-changing may appear laborious, it is only necessary to do it once for the frequency or frequencies on which the transmitter is likely to operate. Once the correct settings have been obtained they should be noted, and the transmitter set up when desired to these settings and not to those of the Tables for the same frequency. If it is necessary at any time to set the transmitter to a frequency for which no tap-changing settings have been previously obtained, then the Tables should be followed. When time permits units should endeavour to obtain for themselves the settings which will give the best results for the new frequency.

Rapid tuning between 4.3 and 6.0 Mc/s

87. When rapid changes of frequency are required between 4.3 and 6.0 Mc/s, it will generally be inconvenient to make all the adjustments referred to in the preceding paragraphs. By sacrificing a little output the essential changes may be reduced to a maximum of five. With practice it is possible to change to any frequency, for which the adjustments are known, in about 15 seconds.

88. Table 5 shows typical sets of adjustments for five frequencies between 4.3 and 6.0 Mc/s. A similar table should be prepared for each transmitter for the particular frequencies on which it will be worked, and should be prominently displayed near the transmitter.

89. It will be noticed that the occasions on which it is necessary to switch off the H.T. in order to make adjustments inside the transmitter are limited. The amplifier bias tap, stud 4, is such that the frequency may be safely changed without altering either the bias tap or the H.T. tap which may be left on stud 2 whilst tuning. The aerial current, i.e. the unmodulated carrier, should not be less than 1.9 amp. for each frequency adjustment.

Crystal monitor

90. In order that a rapid and correct check can be made on the frequency radiated by the transmitter, a Crystal Monitor (Stores Ref. 10A/10941) has been developed. The monitor is provided with a set of six crystals which will give six spot frequencies. It will be necessary to calibrate the crystal monitor before making a check on the frequency and the following procedure must be adopted:—

Calibration

91. Place the crystal monitor near the transmitter and ensure that the mains switch on the front panel is off. Remove the perforated back cover and insert crystals corresponding to the frequencies required in the crystal-holder. Ascertain the position of the arrow head on the selector switch corresponding to the selected crystal positions and make a mark to provide a reference to these points. Replace the back cover. Connect the loud speaker to the two-pole socket on the side of the monitor and connect the A.C. mains plug to the two-pole socket on the back of the power source unit.

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92. Set the selector switch to the desired frequency, and switch on the mains switch control. Adjust the master-oscillator control of the transmitter until an audible note is produced in the monitor loud-speaker. Adjust the capacitance of the condenser associated with the particular crystal until the note reaches a maximum. A small screwdriver may be used for this purpose, but it should be noted that the potentiometer control should also be adjusted during the operation to suit the relative position of the monitor and transmitter.

93. Adjust the various component controls on the transmitter to arrive at the frequency settings corresponding to the selected crystal in the monitor. The attainment of this frequency will be indicated by the "Dead Space" of the beat note produced in the loud speaker. Make a note of the transmitter settings corresponding to this particular frequency in tabular form. Repeat the transmitter settings for each of the selected crystal positions of the monitor. After the adjustments have been completed, two sets of readings will be available, one for the settings of the transmitter controls, and one for the corresponding positions of the selector switch on the monitor.

Frequency monitoring

94. In order to monitor the frequency radiated by the transmitter, switch on the crystal monitor, set the selector switch on the monitor to the position for the desired frequency and, if necessary, adjust the transmitter controls to the "Dead Space" of the beat note produced in the loud speaker.

Frequency changing

95. In order to effect a rapid change of frequency, switch on the crystal monitor, set the selector switch to the position corresponding to the desired frequency, and set the transmitter controls in accordance with the tables produced in the initial calibration as described in para. 92.. Adjust the tuning of the transmitter to the "Dead Space" of the beat note produced in the loud speaker. With practice, a change of frequency can be effected in less than one minute, even in the extreme case where the number of adjustments to be made is a maximum.

96. It should be noted that a seventh or off position is provided on the selector switch. Hence by leaving the mains switch in the on position and placing the selector switch in the off position, the crystal monitor may be left in a virtually inactive state ready for instant use by adjustment of the selector switch. It should also be noted that as no engraving has been provided for the mains switch, the signal lamp should be observed to ensure that the power supply is disconnected when not required. If a crystal monitor is not available, a wavemeter, type W.39A, modified for crystal control may be set up and used as described in the chapter dealing with this wavemeter.

PRECAUTIONS AND MAINTENANCE

97. Before commencing to use the transmitter see that all external leads are correctly connected. Check over the leads (where used) from the valves to the valve-holders. See that the various taps are in the correct position. Check the link connections between the rectifier unit and the transmitter. The link connections should make good contact and the nuts on both inside and outside of the insulating bars should be tightened with a spanner. The conductor connecting the frame of the transmitter to earth should be as short as possible. Finally, check over the connections on the terminals at the base of the rectifier unit and the connections between the transmitter and the remote control unit, depending on which system is being used.

98. Switch off the H.T. before making any changes which necessitate opening the doors of the transmitter. Do not rely wholly on the safety door switches. These switches only isolate the power supply but a number of condensers of large capacitance exist in various circuits and these take a few seconds to discharge. A period of about 15 to 20 seconds should be allowed to elapse before making any adjustments inside the transmitter after opening the doors. On M.C.W. or C.W. the condensers may be discharged by tapping the key. See that the main switch is off before unscrewing any of the side or back panels.

99. See that the adjustment of the contacts of the H.T. switch (S_{17} , fig. 2) is such that the contacts in the primary circuit of the transformer, i.e. the lower contacts, close before the contacts which short-circuit the 1,000-ohm resistance, i.e. the upper contacts. Care must be taken to ensure that the lower contacts are not set so far in advance of the upper contacts that the operating force of the relay is insufficient to close the latter.

100. Always switch on the filament supply first and then the H.T. supply. When shutting down, the procedure should be reversed; H.T. first and then the filaments. The transmitter filament and H.T. supplies should be switched on for ten minutes or so before the commencement of routine transmission. In the case of this transmitter it is advisable to leave the filaments switched on during pauses in transmission in order to minimize the possibility of frequency creep as the master-oscillator warms up. This may be accomplished by leaving the local filament switch on the type 3 remote control unit in the on position.

101. The valves used in the rectifier are two type V.U.29 valves. These valves are of the mercury vapour type, and whenever there is any possibility of the mercury having come in contact with the filaments, the filament circuit should be switched on for at least 10 minutes before the H.T. is switched on, or the valves may be seriously damaged. These remarks apply in any instance where a valve is moved or where the complete rectifier panel has been moved and has been subjected to inversion or heavy vibration.

102. It is very important that the A.C. mains voltage at the transmitter terminals does not drop below 230 volts or several transformers in the transmitter will be affected. The filament supply for the V.U.29 valves in the rectifier should never drop below 4 volts, or the life of the valves will be impaired. The filament transformer in the rectifier has a tapped secondary-winding giving 14 volts and 20 volts A.C. The 14 volt A.C. is reduced to 12.5 volts for the M/O and 11.25 volts for the amplifier valves and the bias rectifying valve, rheostats being employed for this purpose.

103. The 20-volt tapping supplies the three metal rectifiers for operating the relays. One rectifier provides the D.C. voltage for operating the delay relays in the rectifier, the other two are connected in parallel and provide the D.C. voltage for operating the relays in the transmitter. Since the D.C. output from the rectifiers depends on the A.C. input, which in turn depends on the input of the filament transformer, the necessity for keeping the mains at 230 will be appreciated.

104. After the transmitter has been in use some time, the neon lamp (3, fig. 1) may become "hard" owing to ageing, which will be indicated by a blackening of the glass. In these circumstances the lamp may not strike up when the amplifiers are near tune because a greater voltage is required to strike the neon. If, when following the normal tuning procedure the lamp fails to light, reduce the bias until the amplifiers are taking some anode current. This should not exceed 100 mA with the amplifiers off tune. The lamp should strike up, and if the amplifier stage is tuned in the normal manner, the lamp will glow at its brightest at the tune position. Now set the bias back to 8 and the lamp should remain alight. Proceed with neutralizing. If during neutralizing, the lamp fails to strike again when the condenser control is moved in the opposite direction, reduce the bias till the lamp strikes, then move the bias back to 8 and carry on with neutralizing. If however the lamp fails to strike at all in these circumstances it is probably defective and should be replaced. Before finally deciding on the lamp, however, make a careful check on the transmitter and ensure that the coil settings are correct, and that the relay S_1 , fig. 2 has operated to transfer the M/O to the amplifier.

105. Some cases of failure have occurred of the condenser connected across the keying relay (C_{26} , fig. 2). This may be evident both visually and aurally. With the H.T. switched on and the bias at 8, if C_{26} has broken down completely, the transmitter will radiate continually as though the key were down, because in effect the contacts of S_3 are shorted through the resistance R_{12} . If the fault is partial, intermittent transmission will take place, because with the grid-bias at 8, the maximum bias volts from the valve V_1 are virtually across C_{26} . As this voltage may be of the order of 1,000 volts, it may be enough to break down the faulty condenser.

106. A partially defective condenser may be tested in the following manner. Switch off the H.T. and set the bias to 8. The transformer T_2 will still be energized since the primary

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is connected across the amplifier filament supply, and the bias volts generated by V_4 are across C_{26} . If the condenser is faulty, it will make a clicking noise every time the condenser flashes over. This flash over may not be apparent in the form of arcing, because it will probably occur inside the condenser, but it will certainly be heard. If when the bias is moved to 0, thus reducing the volts across C_{26} , the noise ceases, the condenser is obviously defective and should be replaced.

107. The condenser (C_{27} , fig. 2) is connected between the screen grids of the amplifier valves and earth. Should it become defective and short-circuit, the fault will be apparent by one or both of the following symptoms. Arcing may occur on the relay type T (S_2 , fig. 2), resulting in the burning of the movable copper arm associated with H.T. positive contact, and accompanied in extreme cases by corrosion of the exposed metal parts of the relay. This will be more noticeable when using the higher H.T. studs. With the H.T. switch on Stud 1, the amplifier valves should normally start taking anode current when the bias is moved from stud 8 to stud 7. If C_{27} is short-circuited, then it will be noticed that the anode current does not start until the bias has been reduced to stud 4 or even 3.

108. As soon as either or both the defects are suspected, units are to make an insulation test. Remove the amplifier valve panel and withdraw the 100,000 ohm resistance (14, fig. 8) from its holder. The insulation should then be tested between the top contact of the resistance holder and the frame of the transmitter. A tester bridge megger should be used for this purpose and, if a reading of appreciably less than infinity be obtained, the condenser should be replaced.

109. Some cases of failure have occurred in certain of the resistances incorporated in the transmitter. When any of the following resistances fail they should be replaced by the corresponding tropical grade as follows:—

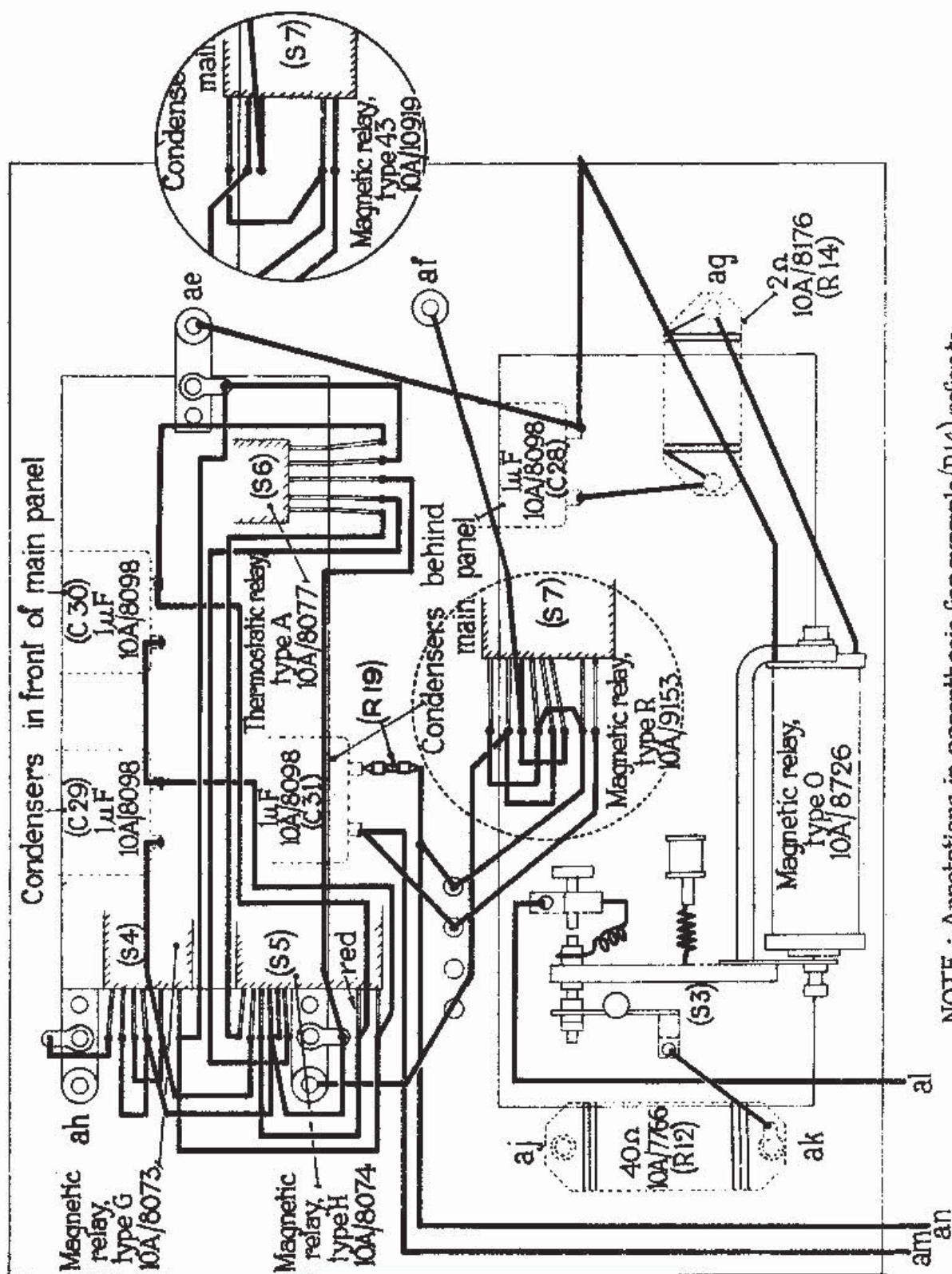
		Original			Replacement
Type	86	10A/7770	Type	304	10A/9818
„	888	10A/7772	„	302	10A/9816
„	187	10A/8730	„	309	10A/9823
„	189	10A/8732	„	308	10A/9822
„	233	10A/9157	„	310	10A/9824
„	235	10A/9159	„	323	10A/9862
„	236	10A/9160	„	324	10A/9863
„	237	10A/9161	„	325	10A/9864

Future contract issues of the transmitter will have these tropical grades incorporated.

110. The magnetic relay, type R is prone to failure, one of the symptoms being an inability to respond to the keying of dots at high speed. When this relay becomes unserviceable it is to be replaced by Relay, Magnetic, type 43 (Stores Ref. 10A/10919). The manner in which the new relay should be connected up is shown in the insert in fig. 21. The component shown in the dotted circle is relay, type R, whilst the component in the full circle is relay, type 43. In addition a 100-ohm resistance type 263 is connected in series with the condenser across the relay, to prevent arcing across the contacts of the sounder relay (Stores Ref. 5C/138) on remote controls types 3 or 4.

111. The transmitter may display instability when used on certain frequencies above 10 Mc/s. This becomes evident in the form of low frequency "motor-boating" and poor R/F efficiency as shown by a definite reduction of aerial current. It is partly due to the R/F choke in the H.T. supply to the amplifier valves being of such electrical dimensions as to cause this instability. A modification to overcome this defect is to reduce the number of turns on the choke to 51. The modified choke will adopt the new nomenclature Choke, H/F, type 43 (Stores Ref. 10A/10986).

112. The modified wiring referred to in para. 74 and shown in fig. 19 must only be applied to transmitters which are used solely for R/T, it must not be applied to transmitters which are required to make a rapid change from R/T to telegraphy. The following table shows how the transmitter is controlled by the switch, type 44, at the operations end. It should be noted that, during the intervals between R/T transmission, the switch, type 44, must be placed in the "Generator running" position; furthermore, telegraphy cannot be transmitted with the modified connections.



NOTE : Annotations in parenthesis, for example (R14), refer to the corresponding annotations in Fig. 2

Position of Switch, type 44.			Condition of Transmitter.
Off			Off
Generator running	..	..	H.T. and filaments on, after 10 seconds M/O is on (stand-by frequency) but amplifier is off.
Transmit	..	..	H.T. filaments and key are on. M/O and amplifiers are on desired frequency. Carrier wave is radiated; ready to speak.
Generator running	..	..	H.T. and filaments on, key up. After 10 seconds M/O is on (stand-by frequency), but amplifier is off.
Off.			All off.

113. It is difficult to see the V.T.25 bias valve from the front of the transmitter and occasions have arisen where the filament of the valve had burnt out and, owing to its position, the defect was not apparent. On C.W. the bias switch should be set at stud 0 for maximum output. At this position of the switch the bias is zero, and the transmitter will operate normally even though the bias valve is defective. In these circumstances, the resistance connected across the valve becomes a grid leak and, as the grid current through it is small, insufficient volts are dropped to provide enough bias voltage to shut down the amplifier valves. The indication of a burnt out filament on the bias valve is that, with the bias switch on stud 8, the amplifier valves will be taking some anode current instead of nothing.

114. Some cases have occurred where the filament of the bias valve has sagged, when hot, and makes contact with the grid. This fault will be indicated by a normal anode current reading when the bias switch is on stud 8 and the transmitter will radiate at the normal output. As the bias switch is reduced progressively from 8 to 0, the anode milliammeter will show a minimum reading at about stud 4 or 5. This dip in anode current is due to the charging and discharging of the condenser connected across the bias resistance.

TABLE 1

Settings of T.1087 for C/W signalling, with balanced load of 600 ohms, using terminals 12 and 14.

Freq. kc/s.	Master Oscillator.		Amplifier Anode Coil and Tuning.				Output Transformer.				Ampl. Grid-Bias Stud.	Ampl. Anode Curr. mA.	Aerial Tuning Cond.	Load Curr. Amps.
	Coil.	Con- denser.	Anode Taps.	Tuned Taps.	Condensers.		Input Sockets.		Output Sockets.					
					Fixed.	Vari- able.	1	2	3	4				
	(L1)	(C1)	(L2)	(L2)	(S16)	(C13)	(L3)	(L3)	(L3)	(L3)	(S15)	(M5)	(C18)	
3,800	E	5-50	CEH	M	B	1-41	E yel.	E red	G wh.	G Blk.	1	245	—	0.66
4,286	E	3-96	CEH	M	A	4-00	D "	D "	F "	F "	1	240	—	0.68
5,550	E	2-50	CEH	L	B	6-00	Q "	Q "	B "	B "	1	220	—	0.62
6,680	E	2-00	CEH	M	A	1-18	D "	D "	D "	D "	1	255	—	0.69
6,820	E	1-83	CEH	L	A	2-23	M "	M "	D "	D "	1	240	—	0.66
6,500	D	5-72	CEH	L	A	4-68	Q "	Q "	D "	D "	1	200	—	0.6
6,820	D	5-07	CEH	L	A	1-90	M "	M "	D "	D "	1	235	—	0.6
6,500	C	8-97	CEH	L	A	4-68	Q "	Q "	D "	D "	1	200	—	0.49
8,400	C	5-00	CEG	K	A	3-47	P "	P "	G "	C "	1	255	—	0.5
8,400	C	5-00	CF	K	A	8-68	Q "	Q "	D "	D "	2	230	—	0.48
10,700	C	3-00	CF	K	A	3-00	Q "	Q "	F "	F "	1	240	—	0.55
10,700	C	3-00	CF	J	B	4-29	H "	H "	E "	E "	2	230	—	0.52
11,400	C	2-60	CF	J	A	3-05	E "	E "	D "	D "	3	230	—	0.52
13,350	C	1-80	D	J	A	8-15	G "	G "	D "	D "	3	190	—	0.38
14,620	C	1-34	D	J	A	3-70	M "	L "	D "	D "	2	220	—	0.39
13,350	B	2-20	D	J	A	8-15	G "	G "	D "	D "	2	200	—	0.35
14,620	B	1-90	D	J	A	3-75	E "	E "	D "	D "	1	250	—	0.34
14,620	A	2-00	B	J	A	8-50	D "	D "	B "	B "	2	200	—	0.29
17,500	A	1-50	B	J	A	1-61	D "	D "	B "	B "	1	228	—	0.35
17,500	A	1-50	A	J	A	5-83	E "	K "	K "	H "	2	215	—	0.24
20,000	A	1-10	A	J	A	1-22	E "	K "	K "	H "	2	230	—	0.29

TABLE 2

Settings of T.1087 for R/T signalling with 4-wire cage aerial 7 ft. 6 in. top and counterpoise using terminal 12 for earth and 13 for aerial.

Fre- quency Kc/s.	Master- Oscillator.		Amplifier.						Output Transformer.				Neutra- lizing.	Bias Stud.	Ampli- fier mA Output.	Aerial Tuning Con- denser (Degrees)	Aerial Current	
	Coil. Tuning.		Anode Tap.		Closed Circuit Tuning.				Input Sockets.		Output Sockets.							
			Back.	Front.	Back.	Front.	Fixed.	Vari- able.										
									(L1)	(C1)	(L2)	(L2)						(L2)
8,400	E	1-45	(L2) CF	(L2) CF	(L2) K	(L2) K	(L2) K	(L2) K	(S16) A	(C13) 5-10	D	D	D	D	4	115	0°	0.85
8,000	E	1-58	CF	CF	K	K	K	K	A	6-73	D	D	D	D	4	105	20°	1.0
7,500	E	1-78	CF	CF	L	L	L	L	A	2-90	D	D	D	D	3	135	25°	1.15
7,000	E	2-0	CEG	CEG	L	L	L	L	A	2-43	G	G	D	D	3	125	27°	1.25
6,700	E	2-15	CEG	CEG	L	L	L	L	A	3-52	G	G	D	D	4	110	35°	1.15
6,000	E	2-62	CEG	CEG	L	L	L	L	A	6-40	J	J	D	D	4	110	55°	1.4
5,400	E	3-14	CEG	CEG	L	L	L	L	B	2-12	L	L	D	D	4	110	160°	1.5
5,000	E	3-58	CEG	CEG	M	M	M	M	A	2-87	K	K	D	D	3	145	170°	2.0
4,600	E	3-79	CEG	CEG	M	M	M	M	A	3-74	K	K	D	D	3	150	170°	2.0
4,250	E	4-73	CEG	CEG	M	M	M	M	A	5-92	K	K	F	F	3	115	170°	2.0

H.T. Stud 2. Volts on load, 2,100.

TABLE 3

Settings of T.1087 for C.W. signalling with 54-ft. cage aerial and radial earth using terminal 12 for earth and 13 for aerial.

5,100	E	3-60	CEG	CEG	L	L	B	3-10	Red.	Yellow.	White.	Black.	0	300	16°	1.3			
		3-38	CEG	CEG	L	L	B	4-90	G	G	A	A					87°	26°	1.3
		4-08	CEG	CEG	L	L	B	7-38	G	G	A	A					87°	20°	1.62
		4-33	CEH	CEH	M	M	A	3-24	D	D	B	B					87°	20°	1.95
4,482	E	4-54	CEH	CEH	M	M	A	3-70	D	D	B	B	0	320	23°	2.05			
4,368	E	4-90	CEH	CEH	M	M	A	4-59	D	D	B	B	0	280	26°	2.25			
4,195	E	5-55	CEH	CEH	M	M	A	5-87	E	E	B	B	0	370	35°	2.75			
3,900	E	6-08	CEH	CEH	M	M	A	7-00	E	E	B	B	0	320	40°	2.3			
3,700	E	6-73	CEH	CEH	M	M	A	8-45	E	E	B	B	0	290	45°	2.3			
3,500	E	7-50	CEH	CEH	M	M	B	3-45	E	E	B	B	0	280	63°	2.6			
3,300	E	8-15	CEH	CEH	M	M	B	4-72	F	F	B	B	0	300	82°	2.7			
3,150	E	9-53	CEH	CEH	M	M	B	7-70	G	G	B	B	0	300	136°	3.0			

H.T. Stud 2. Volts on load, 2,000.

TABLE 4

Settings of T.1087 for R/T, C.W. or M.C.W. signalling, with aerial 54 ft., 6-wire cage to 70 ft. mast and radial earth, using terminals 12 and 14.

Freq. kc/s.	Master Oscillator.		Amplifier Anode Coil and Tuning.				Output Transformer.				Ampl. Grid- Bias Stud.	Ampl. Anode Curr. mA.	Aerial Tuning Cond.	Load Curr. Amps.
	Coil.	Con- denser.	Anode Taps.	Tuned Taps.	Condensers.		Input Sockets.		Output Sockets.					
					Fixed.	Vari- able.								
1,500	(L1) F	(C1) 6-50	(L2) CEH	(L2) N	(S16) C	(C13) 7-07	(L3) Q red	(L3) A yel.	(L3) P wh.	(L3) P blk.	(S15) 1*	(M5) 255	(C18) —	3.6
1,605	F	5-75	CEH	N	C	4-72	L "	A "	P "	L "	1*	240	—	3.6
1,720	F	5-00	CEH	N	B	8-00	L "	C red	L "	J "	1*	215	—	3.4
1,920	F	4-10	CEH	N	B	4-90	L "	C "	L "	L "	1*	200	—	3.1
2,130	F	3-35	CEH	N	A	8-00	L "	C "	H "	H "	1*	200	—	3.1
2,375	F	2-75	CEH	N	A	5-83	L "	B "	F "	F "	1*	240	—	3.3
2,630	F	2-30	CEH	N	A	4-20	L "	C "	F "	A "	1*	220	—	2.82
3,050	F	1-83	CEH	N	A	2-32	L "	C "	F "	A "	1*	225	—	2.15

*For R/T and M.C.W. use bias stud 3.

TABLE 5

Settings of T.1087 for rapid frequency change made with a standard T type aerial, with 7 ft. 6 in. roof and counterpoise.

Frequency kc/s.	Master-Oscillator Condenser.		Amplifier Anode Coil and Tuning.					Bias Stud.	Output Transformer.		Aerial Tuning Condenser.
	Turns.	Degree.	Anode Taps.	Tuned Taps.	Condensers.		Input Sockets.		Output Sockets.		
					Fixed.	Variable.					
4,338	4	65	C.F.	L	C	5-46	4	D.D.	E.E.	180	
4,500	4	33	C.F.	L	C	6-75	4	G.G.	E.E.	180	
5,000	3	61	C.F.	L	B	7-62	4	G.G.	E.E.	180	
5,500	3	05	C.F.	L	B	3-90	4	G.G.	E.E.	180	
6,000	2	63	C.F.	L	A	8-05	4	G.G.	E.E.	180	
								Switch off H.T. before adjusting.			

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APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Qty.	Remarks.
10A/8709	Transmitter, type T.1087		Without valves or indicating lamps.
	Principal components :—		
10A/7180	Ammeter, thermo 0-6 amps	1	
10A/9166	Case, stowage	1	For M/O coils and resistances.
	Choke, H/F		
10A/8716	Type 22	3	
10A/8717	Type 23	1	
10A/8718	Type 24	1	
10A/9514	Type 35	2	
10A/10986	Type 43	1	
10A/7512	Choke, L/F, type C	1	
	Coil, inductance		
10A/8713	No. 1	1	M/O range A, 20,000 to 17,000 kc/s.
10A/8710	No. 2	1	M/O ranges B, C, D and E, 18,750 to 3,000 kc/s.
10A/8728	No. 3	1	M/O range F, 3,000 to 1,500 kc/s.
10A/8711	No. 4	1	Amplifier, 20,000 to 1,500 kc/s.
10A/8712	No. 5	1	Output transformer 20,000 to 1,500 kc/s.
	Condenser		
10A/7764	Type 109	1	0.002 μ F.
10A/8098	Type 146	6	1.0 μ F.
10A/8163	Type 151	5	0.01 μ F.
10A/8166	Type 154	1	300 $\mu\mu$ F.
10A/8170	Type 158	12	50 $\mu\mu$ F.
10A/8496	Type 188	1	0.01 μ F.
10A/8719	Type 217	1	Variable, neutralizing.
10A/8720	Type 218	2	40 to 800 $\mu\mu$ F. variable.
10A/8721	Type 219	2	100 $\mu\mu$ F. matched pair.
10A/8722	Type 220	2	20 $\mu\mu$ F. matched pair.
10A/10920	Type 428	15	1.5 μ F.
10A/9151	Type 263	1	40 to 800 $\mu\mu$ F. variable.
10A/9152	Type 264	1	7 to 145 $\mu\mu$ F. variable.
	Connector		
10A/8731	Type A	2	Fitted with sockets and lug ends.
10A/8735	Type B	2	Fitted with sockets and lug ends.
10A/8740	Type C	1	Fitted with sockets and lug ends.
10A/9163	Type D	1	Fitted with sockets and lug ends.
10A/9165	Grid-bias unit	1	Fitted with :— 1 condenser type 151, 4 resistances type 235*, 1 resistance type 236*, 1 resistance type 237*.
	Handle, condenser, vernier drive		
10A/7719	Type B	1	
10A/8723	Type E	2	
10A/8714	Holder, neon lamp	2	
	Holder, valve		
10A/8173	Type G	1	Rectifier (grid-bias).
10A/8724	Type N	1	Master-oscillator.
10A/8725	Type O	1	Amplifier.
10A/8093	Insulator, type 16	3	
	Milliammeter		
10A/3091	0 to 300, type A	1	Master-oscillator, H.T.
10A/3092	0 to 500, type A	1	Amplifier, H.T.

In the event of failure of items marked thus*, see para. 109.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Remarks.
	Transmitter T.1087—(<i>contd.</i>)		
	Principal components—(<i>contd.</i>)		
	Mounting, anti-vibration		
10A/8803	Type 1	3	
10A/8715	Mounting, M/O coils	1	
10A/8068	Panel, rectifying, type A or	1	
10A/11156	Panel, rectifying, type B	1	
	Relay, magnetic		
10A/8073	Type G	1	
10A/8074	Type H	1	
10A/8254	Type M	1	
10A/8726	Type O	1	
10A/9153	Type R	1	In the event of failure, <i>see</i> para. 110.
10A/9154	Type S	1	
10A/9155	Type T	1	
10A/8077	Relay, thermostatic, type A	1	
	Resistance		
10A/7766	Type 82	7	40 Ω
10A/7770	Type 86*	2	10,000 Ω , when 10A/9157 is not in use.
10A/7772	Type 88*	2	50,000 Ω
10A/8176	Type 127	1	2.0 Ω
10A/8729	Type 186	1	1.06 Ω
10A/8730	Type 187*	1	100,000 Ω
10A/8732	Type 189*	1	5,000 Ω
10A/8733	Type 190	1	0.4 Ω , 25 amps. variable.
10A/8734	Type 191	1	0.4 Ω , 15 amps. variable.
10A/9157	Type 233*	2	20,000 Ω , when 10A/7770 is not in use.
10A/9099	Type 263	1	100 Ω .
10A/9863	Type 324	1	15,000 Ω , vitreous rod.
10A/7437	Socket, type 19	1	
5C/622	Switch, tumbler, 5 amp. S.P.	2	
10A/8082	Type 75	4	Gate switches.
10A/8736	Type 88	1	Three-position, radial contacts, fitted with 6 condensers, type 158.
10A/9162	Type 97	1	Fitted with socket, type 19, plug operated.
10A/8737	Transformer, biasing	1	
10A/9164	Transformer, modulating	1	
	Voltmeter		
10A/8183	0 to 15 volts	2	M/O and amplifier filaments.
10A/7784	0 to 3,500 volts	1	D.C. voltage.
	Accessories :—		
10A/7474	Lamp, indicating, neon, No. 1.	2	
	Valve		
10A/8738	Type V.T.30	1	Master-oscillator.
10A/8739	Type V.T.31	2	Amplifiers.
10A/7312	Type V.T.25	1	Biasing.

In the event of failure of items marked thus*, *see* para. 109.

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TRANSMITTER T.1078

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TRANSMITTER T.1078

(Stores Ref. 10A/8292)

INTRODUCTION

1. The transmitter T.1078 is a self-contained ground station transmitter of the master-oscillator type operating on the frequency band 3 to 15 megacycles, and capable of radiating C.W. or modulated C.W. Nine valves are employed, one of which is for the sole purpose of producing a 1,000 cycle modulating frequency. The transmitter is capable of radiating at any frequency within the above-mentioned limits, and all the circuit adjustments necessary to change from

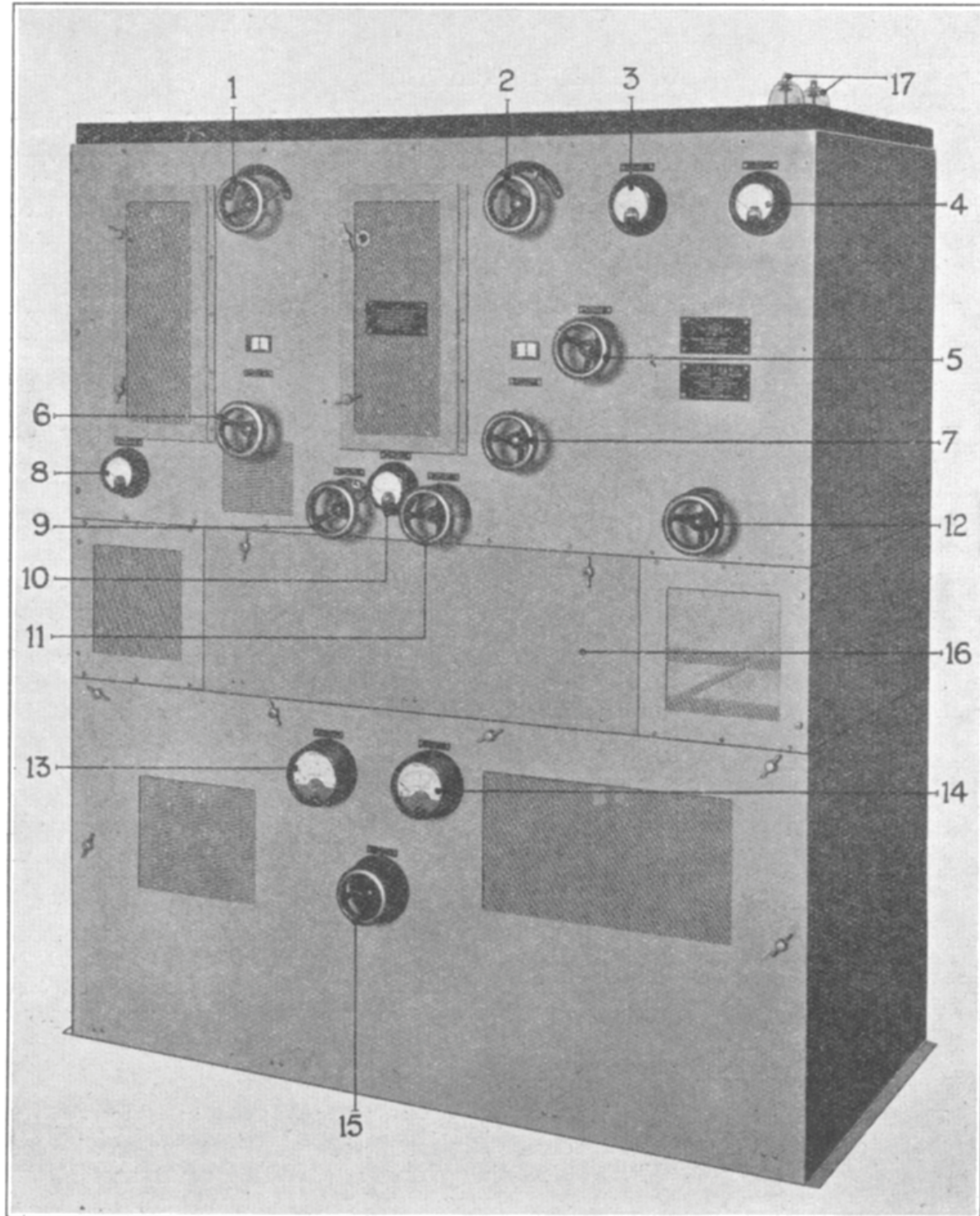


FIG. 1. Front view of transmitter.

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any one frequency to another may be effected in less than ten minutes. The design of the transmitter is such as to provide for connection to a transmission line or for direct connection to an aerial.

2. Accommodation is provided on the transmitter for a standard control panel complete with the necessary sounder relays for remote switching and keying, and the tumbler switches for local operation. The equipment is arranged for 230 volt 50 cycle A.C. single phase supply, the necessary transformers and rectifying apparatus being housed within the cubicles. Safety switches are fitted to all doors of the transmitter. These ensure that the H.T. circuit is broken when any door is opened.

GENERAL DESCRIPTION

3. A theoretical circuit diagram of the transmitter is given in fig. 2. V_1 is the master-oscillator valve, and V_2 the amplifier valve. Coupling between the two is effected entirely by the low impedance link L_x .

4. The inductance coil L_1 in the anode circuit of the master-oscillator is tuned by means of the variable condenser C_{19} , and a portion is tapped off and coupled back through a condenser to the grid to maintain the valve in a state of oscillation.

5. The inductance coil L_2 in the grid circuit of the amplifier is tuned by means of the variable condenser C_{23} , and the inductance coil L_3 in the anode circuit is tuned by means of the variable condenser C_{20} and inductively coupled to the aerial or transmission line through the coil L_4 . The amplifier is neutralized by means of the variable condenser C_{21} .

6. The rectifier V_8V_9 supplies H.T. to the amplifier valve, and the rectifier V_6V_7 supplies H.T. to the master-oscillator valve. A third rectifier V_5 provides bias for the amplifier valve and the necessary rectified supply for operating the relays. It also provides the anode supply for the valve V_3 .

7. The valve V_3 functions as a 1,000 cycle oscillator to supply the modulating frequency for modulated continuous wave transmission. It is coupled to the grid circuit of the grid-leak modulator valve V_4 .

8. Keying is performed by making and breaking the link between the master-oscillator and amplifier, the master-oscillator valve circuit being maintained continuously in an oscillatory condition. To prevent any possibility of radiation the aerial circuit is also made and broken. The operating windings of the two relays X_4 and X_5 which key the link circuit and the aerial circuit, are in series and are energized simultaneously.

9. No temperature control is fitted, but the master-oscillator incorporates a compensating device consisting of a small shunt capacitance C_{26} shown dotted in fig. 2, the value of which decreases with temperature rise. The device is located close to the master-oscillator valve and is controlled by the temperature rise of the latter.

10. All valve filaments, with the exception of that of the master-oscillator, are supplied with A.C., each valve having a separate transformer. The supply to the master-oscillator filament is rectified by means of a copper-oxide rectifier W and smoothed by the choke L_{12} and condenser C_2 . This rectifying and smoothing equipment is housed in the master-oscillator compartment.

Oscillator

11. The transformer T_1 which supplies the current for heating the oscillator filament has an output voltage of 30. In the secondary circuit is a metal rectifier W , an iron-cored smoothing choke L_{12} , and a condenser C_2 . Two 0.125 ohm vitreous embedded resistances R_1 and R_2 are also included in series with the filament. The voltage across the filament is 12. Connected

between grid and filament are the inductance coil L_5 and the resistance R_3 , the latter consisting of eight 1,000 ohm rod-type resistances. The condenser C_1 which effects the coupling between the grid and anode circuits of the oscillator is a special porcelain-encased type condenser having a capacitance of $0.002\mu\text{F}$. The fixed condenser C_{21} which also has a value of $0.002\mu\text{F}$ is connected between the earthed filament and the H.T. feed to the anode inductance of the oscillator. The fixed condenser C_7 which has a value of $0.01\mu\text{F}$ is connected across the milliammeter M_1 (reading 0 to 250 milliamps.) in series with the H.T. feed. A choke coil L_6 is also included in this H.T. feed. The condenser C_3 which has a value of $0.0005\mu\text{F}$ is connected between earth and anode inductance for certain frequencies by means of a link.

12. The variable condenser C_{19} is in three sections ganged together and operated by a common spindle. One of the sections is permanently connected across the anode inductance L_1 , but the other two sections are connected to the switch S_1 and are connected across the inductance for certain positions of the switch. The switch simultaneously makes changes in the inductance values. The actual changes effected in the oscillator anode circuit by the switch are shown in fig. 5.

13. The link L_8 consists of a twisted pair of leads terminated at one end by a turn around the anode inductance of the oscillator and at the other end by a turn around the grid inductance of the amplifier. The twisted pair is made and broken by means of the relay X_4 . The relay incorporates two moving contacts, each of which moves between two fixed contacts. In one position of the contacts the link circuit is completed and in the other position both legs of the link are broken and the portion which terminates at the oscillator inductance is earthed.

Amplifier

14. The grid inductance coil L_2 with its tuning condenser C_{23} and range switch S_2 is housed in a metal box, and a centre tapping is taken out through the choke L_7 and the milliammeter M_2 (0 to 50 milliamps.) to the switch S_4 . A condenser C_4 is connected between the tapping and earthed filament. One end of the grid inductance is connected to the grid and the other end is connected through the neutralizing condenser C_{22} and fixed condenser C_5 to the anode of the amplifying valve. The filament of the valve V_2 is heated from the transformer T_2 , the voltage across the secondary of which is 17.5 volts. Two condensers C_{24} and C_{25} are connected in series across the filament with their junction point earthed. The connections of the anode inductance L_3 , switch S_3 and condenser C_{20} are similar to those employed for the inductance, switch and condenser in the anode circuit of the oscillator valve. The actual changes effected in the amplifier anode circuit by the switch are shown in fig. 5.

15. The H.T. feed to the amplifier anode inductance is through the choke L_8 and milliammeter M_3 (0 to 300 milliamps.), the condenser C_6 being connected from this point to earth. The inductance L_4 which is coupled to the inductance L_3 is connected through the contacts of a relay X_5 which is similar to that in the link circuit, and through a thermo-ammeter M_4 (0 to 1 amp.) to the aerial terminals.

Small rectifier

16. The rectifying valve V_5 is a double-wave thermionic rectifier and supplies, rectified H.T. for the keying relay coils, H.T. for the M.C.W. oscillator valve, and grid bias for the amplifier. The transformer T_4 supplies this valve. It has two secondary windings, one of which applies four volts across the filament, whilst the other applies approximately 600 volts between the anodes. Two 2,000 ohm resistances R_{12} and R_{13} are included in the anode circuits. Smoothing is effected by the condensers C_{13} and C_{14} and the choke L_{15} . Across the output is connected the resistance R_7 which consists of twelve 1,000 ohm rod-type resistances. The keying relay coils

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are connected in series (and in series with the operating key) across this resistance. A connection is taken from the positive end of the resistance to the anode circuit of the valve V_3 , and a tapping is taken from the resistance to the switch S_{4A} . The positive end of the resistance is connected to the filament of the valve V_3 and, the tapping being negative with respect to this, negative bias is thus provided for the amplifier.

Grid-leak modulator valve

17. The grid-leak modulator valve V_4 has its filament heated by the transformer T_3 , the secondary of which has a voltage of 6. Two condensers C_{11} and C_{12} are connected in series across the filament, and the centre point is connected through the resistance R_8 to the C.W.—M.C.W. switch.

18. This switch has two positions, one marked C.W. and the other marked M.C.W. It is shown in two portions (S_4 and S_{4A}) both being operated by the same movement. As will be seen from the diagram, when the switch is in the C.W. position, the negative bias tapping from the valve V_3 is taken *via* the lower contact of the switch S_{4A} to the filament of the valve V_4 and through the two resistances R_4 and R_5 *via* the left-hand connection of the switch S_4 to the centre tapping of the grid inductance of the valve V_2 . When the switch is in the M.C.W. position, the negative grid-bias tapping from the valve V_3 is connected directly to the anode of the valve V_4 . The path may be traced through the filament of the valve, and the right-hand side of the switch S_4 to the grid of valve V_2 . The inductance L_{11} , which is connected between the grid of the valve and filament, is for the purpose of coupling up the M.C.W. oscillator valve.

M.C.W. oscillator valve

19. The valve V_5 is an indirectly heated valve and receives its heating current from the transformer T_3 , the secondary of which has a voltage of 4. The centre-point of the secondary is connected to the cathode. The grid circuit includes the inductance L_{10} and the condenser C_9 shunted by the resistance R_{11} . The anode circuit includes the inductance L_9 shunted by the condenser C_8 . The circuit characteristics of this valve are such as to produce oscillations at a frequency of approximately one thousand cycles per second. These are impressed upon the valve V_4 by the coupling inductances L_{10} and L_{11} . The M.C.W. oscillator remains in a state of oscillation irrespective of the position of the switches S_4 and S_{4A} .

Rectified supply for oscillator

20. The valves V_6 and V_7 are gas-filled rectifying valves, the filament supply for which is obtained from the transformer T_5 . This transformer has two secondaries, one for each valve filament. The centre-points of the secondaries are connected together and from this point the positive H.T. supply is taken. The anodes are connected to tappings on the secondary of the transformer T_6 , and in the anode circuit are included the fuses F_1 and F_2 (350 milliamp.) and the resistances R_9 and R_{10} , the latter having values of 1,000 ohms each. The output is smoothed by means of the choke L_{13} and the two condensers C_{15} and C_{16} . A fuse F_3 (350 milliamp.) is included in the positive H.T. supply lead, and across the output is connected the voltmeter M_6 (0 to 2.5 kilo-volts).

Rectified supply for amplifier

21. The valves V_8 and V_9 are large thermionic rectifying valves, the filament current of which is supplied from the transformer T_4 , the secondary voltage being 13.5. The anodes are connected through 500 milliamp. fuses F_4 and F_5 to the secondary of the transformer T_6 . The output is smoothed by means of choke L_{14} and condensers C_{17} and C_{18} . Across the smoothed output is connected the resistance R_8 which consists of ten 100,000 ohm rod-type resistances.

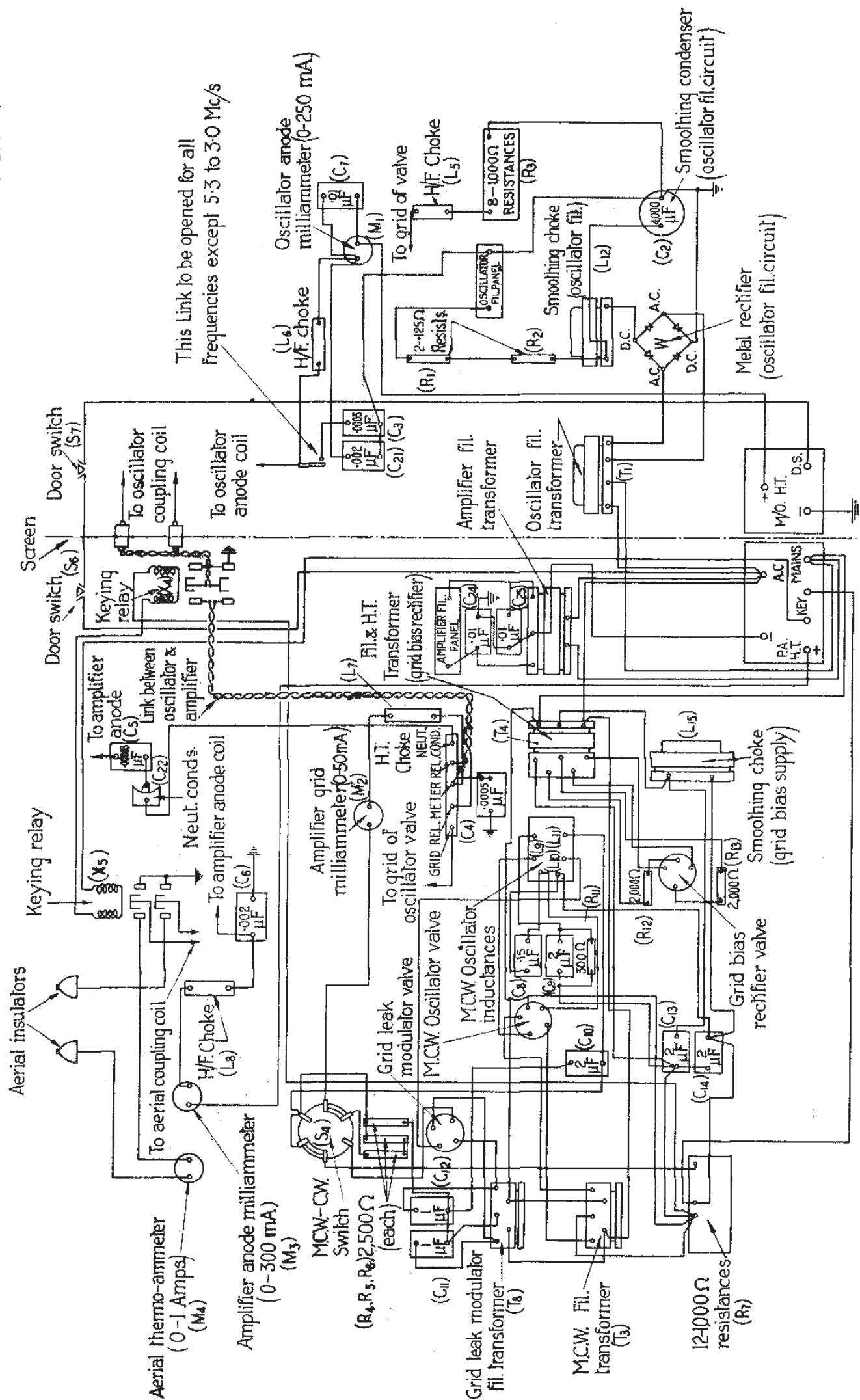


FIG 3. BENCH WIRING DIAGRAM—UPPER CUBICLE

A 500 milliamp. fuse F_6 is included in the positive H.T. supply and a voltmeter M_6 (0 to 4 kilovolts) is connected across the output. The switch S_5 enables the ratio of the transformer T_6 to be varied, thus providing control of power.

Switching relays

22. As will be seen from fig. 2 there are three switching relays X_1 , X_2 , X_3 . These relays are of the S.P., A.C. contactor type, X_1 and X_3 being exactly similar whilst X_2 has an escapement delay action. The winding of relay X_1 has one end permanently connected to one side of the A.C. line. The other end of the relay winding is connected to the terminal engraved L.T. on the terminal board, and when a connection is made between this terminal and the adjacent terminal engraved C, through a local or remote switch, the winding of the relay is connected across the A.C. line. The contacts of the relay which are in series with the A.C. supply to the primaries of the filament transformers now close and all valves of the transmitter have their filaments heated.

23. The relay X_3 has one side of its winding permanently connected to one side of the A.C. line. The other end of the winding is connected to the terminal engraved H.T. on the terminal board, and when a connection is made between this terminal and the terminal engraved C, through a local or remote switch, the winding of the relay is connected across the A.C. line. The contacts of this relay, which are in series with the contacts of the relay X_2 in the A.C. supply leads to the primary of the H.T. transformer, now close. The supply to the primary is not completed, however, unless the contacts of the relay X_2 are also closed. The winding of the relay X_2 is permanently connected at one end to the A.C. mains. The other end is connected through the gate switches S_6 , S_7 , and S_8 to the other side of the A.C. mains. It is, therefore, necessary to have X_1 , X_2 , and X_3 all closed before the H.T. transformer can be energized. As previously mentioned there is an escapement delay action incorporated in the relay X_2 to provide a 30 seconds delay between the energizing of its winding and the closing of its contacts. The arrangement ensures that if either the circuit of the winding of the relay X_1 is broken (by means of the L.T. switch), or the circuit of the winding of the relay X_2 is broken (by opening one of the gate switches) the H.T. supply will be cut off and cannot be re-established until 30 seconds after both windings have been energized. If the windings of X_1 and X_2 are maintained energized, the H.T. may be broken independently by means of the relay X_3 without any delay action taking place.

24. The object of this arrangement is to prevent H.T. being applied to the valves before the filaments are heated, this being particularly important in respect of the gas-filled rectifying valves. When transmission is in progress, however, the operator frequently finds it necessary, during periods of reception, to shut down the oscillator and it would be undesirable to have a 30 seconds delay before transmission could be resumed. The H.T. relay X_3 overcomes this difficulty by placing in the hands of the operator an independent control (through the medium of the H.T. switch in the operating winding of the relay) of the H.T. supply. The filaments remain heated.

Terminal boards

25. As can be seen in fig. 8, there are five terminal boards on the transmitter. Three of these (7), (8) and (9), are conveniently placed at the back of the transmitter to facilitate the interconnection of the cubicles. The two other terminal boards (11) and (10) are situated in the centre and the lower portions of the transmitter respectively. The lower terminal board (10) is provided with eight terminals. Two of these, marked LINES A AND B are for connecting up the incoming control lines. Two are marked A.C. and are for connecting up the incoming 230 volt A.C. supply. Of the remaining four, one is for an earth connection, and the other three, which are marked 1, 2 and 3, are internally connected to the filament relay and to the H.T. relay. No external connections other than the A.C. supply and the incoming control lines

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are made to this board. Internal connections are made between the A.C. supply terminals and the transformers, etc., in the cubicles, and internal connections are taken from the line terminals to two similarly marked terminals on the central terminal board (11). The four remote control terminals, marked 1, 2, 3 AND EARTH, are also internally connected to the central board (11), being marked there as Fil S/W, COMMON, H.T. S/W and EARTH respectively.

26. The three interconnection terminal boards (7), (8) and (9) are connected by means of lead-covered cables after the two cubicles have been placed in position and bolted together. The terminal board (7) carries six terminals. The left-hand two are marked + P.A. H.T.—, and internal connections are taken from these to the circuits of the amplifier valve. The two right-hand terminals are marked A.C. MAINS, and internal connections are taken from these to the transformers, etc., in the upper cubicle. The other two terminals, which are not marked, have internal connections to the keying relay coils. The terminal board (8) carries three terminals. Two are marked +M.O. H.T.—, and internal connections are taken from them to the circuits of the oscillator valve. The third terminal, which is unmarked, is the door switch connection. The terminal board (9) in the lower cubicle carries seven terminals, two marked +P.A. H.T.—, two marked +M.O. H.T.— and two marked A.C. MAINS. The seventh terminal, which is for a door switch connection, is unmarked. The "P.A. H.T." terminals are internally connected to the amplifier rectifier output, and the "M.O. H.T." terminals are connected to the oscillator rectifier output. The "A.C. mains" terminals are connected up to the A.C. supply, one lead being taken through the filament relay.

27. A loom of lead-covered cables is provided for making the inter-cubicle connections. These connections are shown in fig. 12. The loom (shown in the upper part of the illustration) consists of nine lead-covered cables, terminating at each end in thimbles. The thimbles are unmarked and care should be exercised when making or remaking the connections that they are made correctly as shown in fig. 12. It will be seen that at the upper end of the loom nine connections are made, six on the terminal board in the amplifier section of the upper cubicle and three on the terminal board in the oscillator section of the upper cubicle. At the lower end of the loom two of the nine cables, longer than the others, are taken to the key terminals on the centre terminal board (11, fig. 8) and the remaining seven to the terminal board (9, fig. 8) in the lower cubicle.

28. In addition to ensuring that terminals marked with similar polarity are connected together, it is important to make quite certain that the A.C. terminals on the two boards are connected in the correct way. The upper A.C. terminal on one board must be connected to the upper A.C. terminal on the other, and the lower one to the lower one on the other board. *If these connections are reversed the door switches and the H.T. relay coils will be short-circuited.*

Remote control

29. The remote control unit, type 2, which is accommodated in a space between the two cubicles of the transmitter consists of a rectangular metal base approximately 18 × 27 in. At the back of the unit are eight equally-spaced terminals which link up with a terminal strip on the transmitter having a similar number of terminals. At the front of the unit are arranged a push switch and two tumbler switches and the rest of the unit is occupied by a repeating coil and three sounder relays.

30. Referring to fig. 11, the primary of the repeating coil is connected, when the unit is connected up to the transmitter, across the incoming line (terminals A and B) from the operating station. The secondary of the repeating coil is connected on the unit to the windings of the sounder relay which accomplishes the keying of the transmitter. This relay is adjusted to the neutral position and the tongue moves to "mark" or "space" in accordance with the movement of the key at the operating station. Connections are taken from the tongue and mark terminals of the sounder relay to the transmitter key relays, so that when the tongue moves to mark, these relays are energized and when the tongue moves to space they are de-energized.

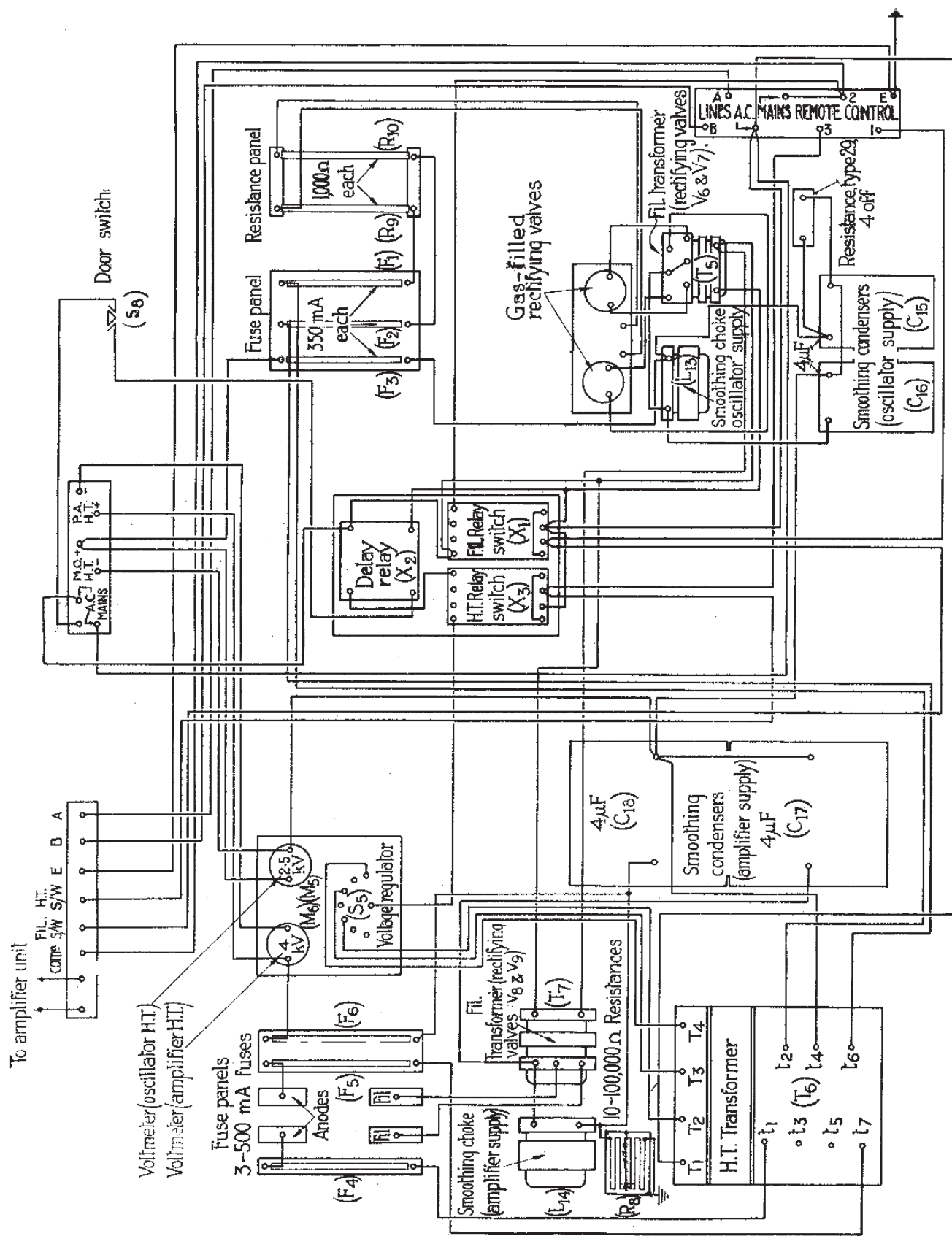
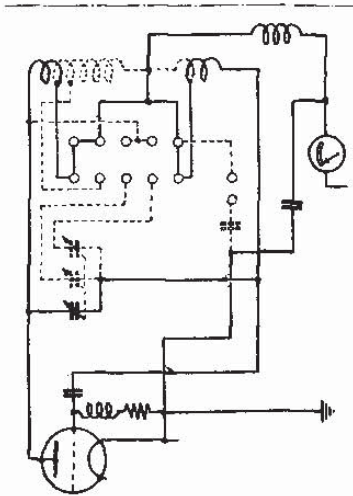
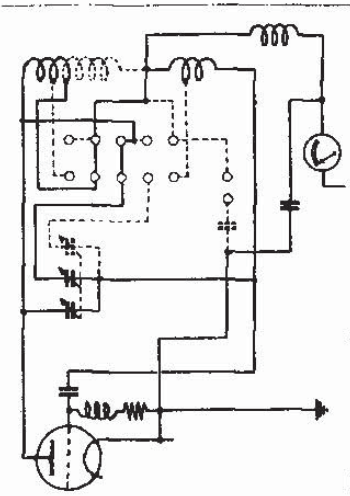


FIG.4. BENCH WIRING DIAGRAM - LOWER CUBICLE

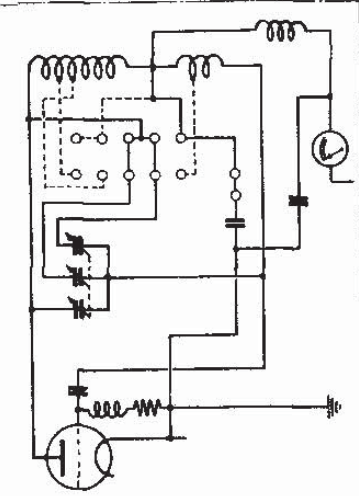
Oscillator



Range 1

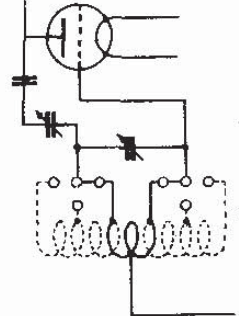


Range 2

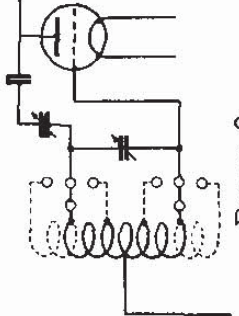


Range 3

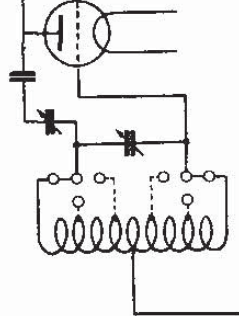
Amplifier grid



Range 1

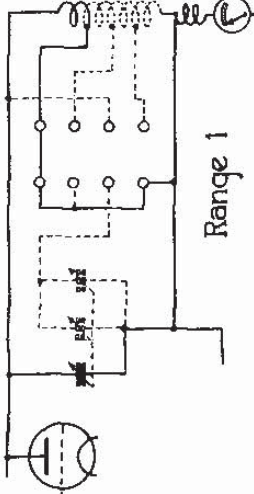


Range 2

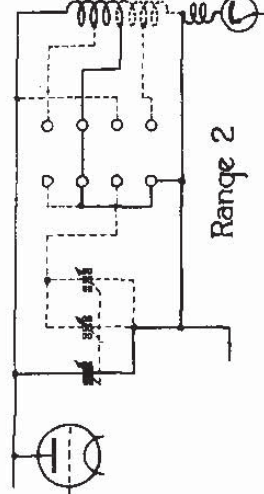


Range 3

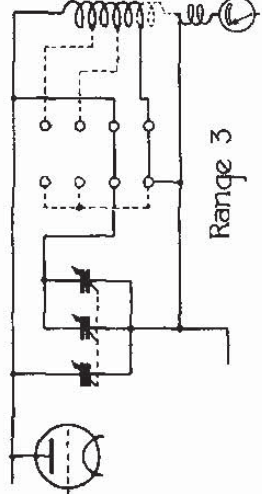
Amplifier anode



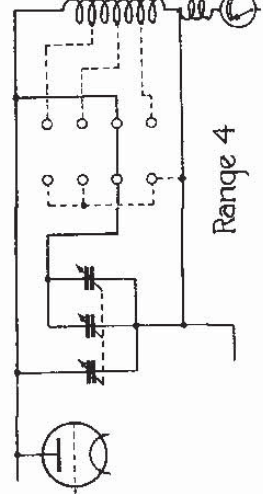
Range 1



Range 2



Range 3



Range 4

FIG. 5. CIRCUIT CHANGES EFFECTED BY RANGE SWITCHES

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31. The other two sounder relays are for the purpose of switching on and off the H.T. and L.T. circuits of the transmitter from the operating station. The method by which switching is accomplished can be seen from an examination of fig. 11. From a centre tap (6) on the primary of the repeating coil, a connection is taken to the (C) terminals of both H.T. and L.T. relays. The D terminals are joined together and earthed. Both relays thus have their windings connected in parallel between the centre of the repeating coil primary and earth. It will be seen, therefore, that if the battery on the operating station is connected between one side of the line and earth, both sounder relays will be energized.

32. The H.T. sounder relay is adjusted to have a space bias, but the L.T. sounder relay is adjusted to the neutral position. The effect of this is that the H.T. relay will normally remain at space and will move to mark only when a current is made to flow in the appropriate direction. When no current flows the tongue will return to space.

33. The tongue of the L.T. relay is adjusted to the neutral position so that it moves to mark when current flows through the relay in one direction or to space when current flows in the reverse direction. It is an important requirement of this relay that the tongue will remain in position at either mark or space after the current which caused the movement has ceased. It will be seen that with this arrangement of the switching relays, the "marking" current may be caused to flow through both relays, and the tongues of both relays will move over to the mark position. So long as this current is maintained, both relays will hold their respective circuits closed. On the cessation of the current, the H.T. relay will open but the L.T. relay will remain closed. If the current is now reversed both relays will be opened.

34. Connections are taken from the tongue and mark terminals of the H.T. relay to the high tension switch on the transmitter. Connections are taken from the L.T. sounder relay to the low tension switch on the transmitter. The distant operator may thus have control of both H.T. and L.T. supply to the transmitter. He may, for example, by merely breaking the switch during a pause in transmission, break the H.T. supply whilst leaving the L.T. on the valve filaments. To shut down the transmitter completely, he merely reverses the current on the line.

CONSTRUCTIONAL DETAILS

35. The transmitter, a front view of which is given in fig. 1, consists of two cubicles, one above the other. The lower cubicle contains the H.T. rectifiers and smoothing equipment, and the upper contains the radio-frequency and modulating circuit equipment.

36. The cubicles consist of rectangular frameworks of angle iron with removable aluminium sides and ends. The two cubicles are separated by distance pieces approximately 9 in. long and in the space thus provided is housed the control unit. The necessary connections between the two cubicles are made by means of lead-covered cables connected between conveniently placed terminal blocks. In fig. 3 is given a bench wiring diagram of the upper cubicle, and in fig. 4 is given a bench wiring diagram of the lower cubicle. The appropriate overall dimensions of the transmitter are 5 ft. 1 in. $\times$ 4 ft. 1 in. $\times$ 2 ft. 3 in., and the approximate weight is 6 cwt. 4 lb.

37. Referring to fig. 1 which shows a view of the front of the panel, the range switch (1) on the extreme left is for the purpose of varying the anode inductance of the master-oscillator, and the range switch (2) to the right of this varies the amplifier anode inductance. To the right of this is the milliammeter (3), reading 0 to 300 milliamperes, in the anode circuit of the amplifier, and to the right of this again is the thermo-ammeter (4), reading 0 to 1 amperes, in the aerial circuit. Beneath this is the handle (5) which controls the aerial coupling. This is provided with a scale engraved 0 to 10 degrees. The oscillator tuning handle (6) and the amplifier tuning handle (7) which rotate the variable condensers connected across the oscillator and amplifier anode inductances respectively, are situated beneath. Both of these are provided with tuning scales rotating behind windows with engraved datum lines. The oscillator scale is calibrated in megacycles but the amplifier scale is engraved in degrees from 0 to 180.

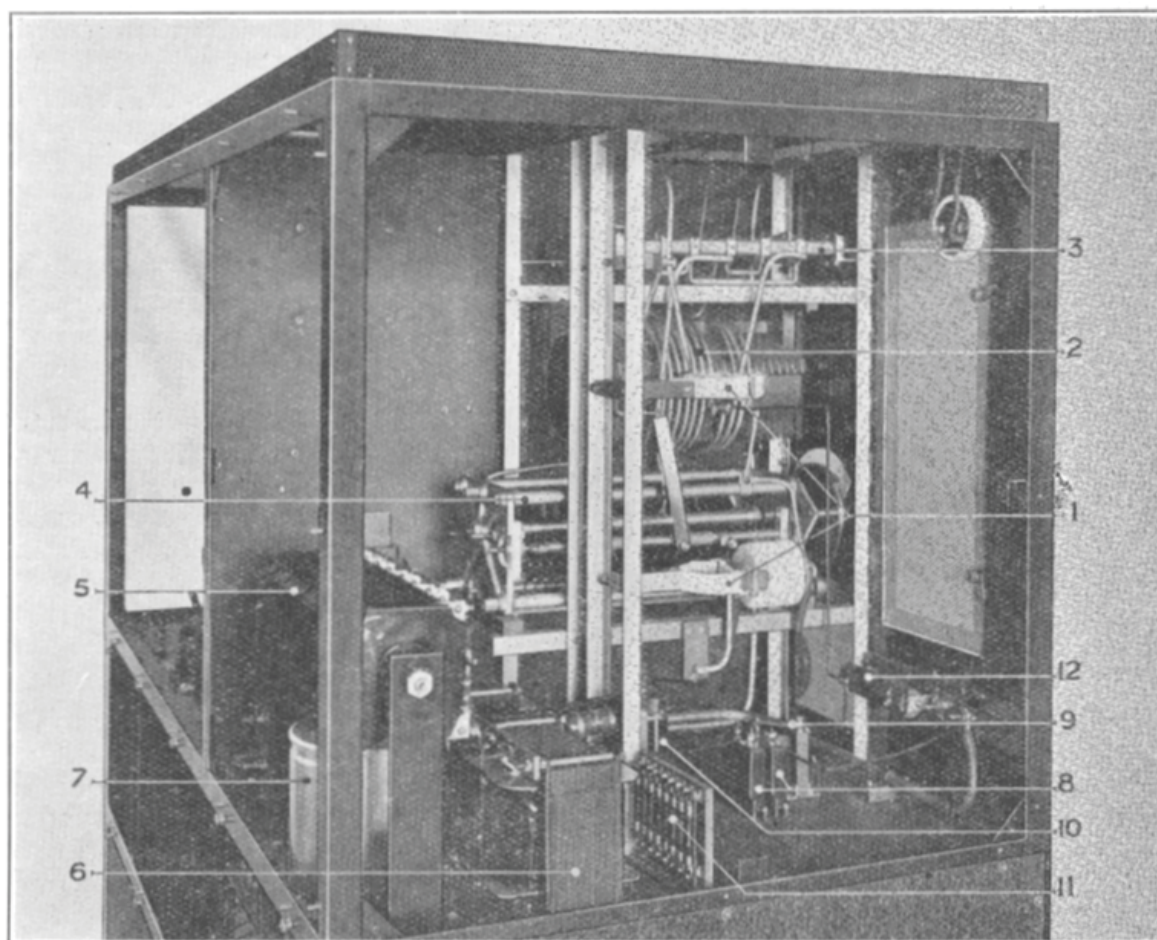


FIG. 6. Oscillator cubicle.

38. In a row beneath these handles are two milliammeters and three control handles. The milliammeter (8) on the extreme left reads from 0 to 250 milliamps. and is connected in the oscillator anode circuit. The range switch handle (9) varies the inductance in the grid circuit of the amplifier. The milliammeter (10), reading 0 to 50 milliamperes, is connected in the amplifier grid circuit. The handle (11) rotates the variable condenser across the amplifier grid inductance, and is provided with a scale reading 0 to 100 degrees. On the right of this can be seen the handle (12) which controls the modulator switch. In one position pure C.W. is radiated and in the other position modulated C.W. is radiated.

39. Below the removable panel (16) which gives access to the remote control unit, there are two meters and one control handle. The left-hand meter (13) reads from 0 to 2.5 kilo-volts and is connected across the output of the rectifier supplying the H.T. to the oscillator valve. The right-hand meter (14) reads 0 to 4 kilo-volts and is connected across the output of the rectifier supplying the amplifier. The control handle (15) has three positions marked 1, 2 and 3 and varies the tap on the primary of the main H.T. transformer.

Upper cubicle

40. In fig. 6 can be seen the interior of the master-oscillator cubicle. The valve is held in the holder (1) mounted upon aluminium uprights. Behind the valve-holder can be seen the anode inductance (2) on which is also wound the reaction and coupling windings. Above this

is the oscillator range switch (3) consisting of a rod of insulating material on which are mounted metal plates, which in the various positions of the switch make the necessary connections to bring into circuit the appropriate amount of the oscillator inductance for the required frequency band. Beneath the inductance is the oscillator tuning condenser (4) which consists of three air-dielectric condensers on a common spindle. The three sections of the condenser are connected up to the range switch (3) and either one, two, or three sections may be connected across the oscillator inductance, depending upon the position of the range switch.

41. The apparatus for the filament supply to the oscillator valve can be seen on the left. It consists of the metal rectifier (5), the choke (6) and the electrolytic condenser (7). On the floor of the cubicle are the two condensers (8) (C_3 and C_{21} , fig. 2) one of which may be disconnected for certain frequencies (*see* para. 56) by uncoupling the link (9). The inductance (10) and the eight 1,000 ohm resistances (11) are in the grid circuit. On the front panel of the cubicle beneath the lower edge of the door is the H/F choke (12) connected in the H.T. feed to the oscillator.

Amplifier cubicle

42. In fig. 7 is given a rear view of the amplifier cubicle. The amplifier valve is carried in the holder (10) mounted upon aluminium uprights. Near the centre of the cubicle can be seen the amplifier anode inductance (1) inside of which is the aerial coupling coil operated by the handle (5, fig. 1) on the front of the panel. Above this is the amplifier anode range switch (2). Above this is the amplifier anode range switch (2).

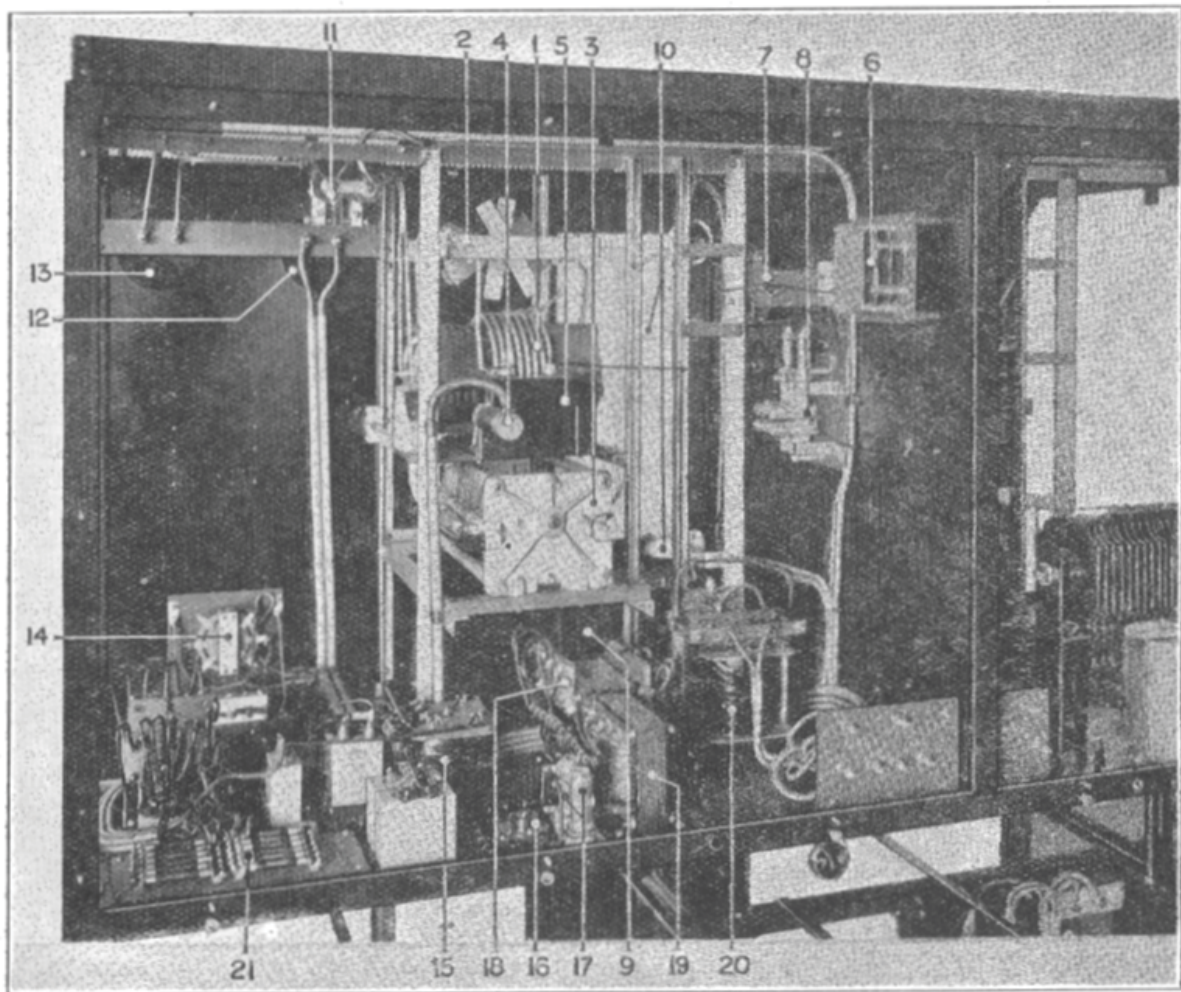


FIG. 7. Amplifier cubicle.

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which is similar in construction to the oscillator range switch previously described. Beneath the inductance is the condenser (3) which tunes the anode inductance of the amplifier. This condenser, like the oscillator condenser, is in three sections, one or more sections being connected across the inductance by the amplifier range switch. Mounted near the inductance is the H/F choke (4) in series with the H.T. supply to the amplifier, and near this is the fixed condenser (5) which corresponds to C_6 , (fig. 2) and is connected between earth and the end of the inductance remote from the anode. The air-dielectric condenser (6) mounted on the side of the cubicle is in series in the anode connection to the neutralizing condenser (7). Near this and mounted on the same wall of the cubicle, is the relay (8) which keys the coupling link between the oscillator and amplifier circuits. A pair of wires twisted together makes connection between this and a metal compartment (9) in which is housed the amplifier grid inductance and its tuning condenser. The relay (11) which keys the aerial circuit is situated at the top of the cubicle to the left. The rear of the amplifier milliammeter (12) and the aerial thermo-ammeter (13) can be seen on the left. On the lower part of this panel is mounted the C.W.—M.C.W. switch (14) and on the floor of the cubicle near by are the valve-holders for the grid-leak modulator and M.C.W. oscillator with their associated equipment. The coupling coil unit (15) has three windings (L_9 , L_{10} and L_{11} , fig. 2) one of which is in the anode circuit of the M.C.W. valve, one in the grid circuit of this valve and one in the grid circuit of the grid modulator valve.

43. The double wave rectifying valve which supplies the D.C. for operating the keying relays, the necessary grid bias for the amplifying valve and the H.T. supply for the M.C.W. valve is held in the holder (16), the choke (17), being connected in the anode leads. The filament and H.T. supplies for this valve are obtained from the transformer (18), and a bank consisting of twelve 1,000 ohm resistances (21) in series is connected across the rectified output from the valve. The positive side of this supply is earthed and a tapping is taken from the resistance bank for the grid bias supply to the amplifier valve. The two keying relay windings are connected in series with one another, and in series with the manual key right across the resistance bank.

Lower cubicle

44. The interior of the lower cubicle can be seen in figs. 8 and 9. Referring to fig. 9 the Edison-screw valve-holders (1) and (2) accommodate the gas-filled rectifying valves which supply the rectified H.T. to the oscillator valve. The fuseboard (5) carries three 350 milliamperce fuses. One of these is connected in the positive H.T. supply lead to the oscillator and one in each anode circuit of the rectifier. Two 1,000 ohm resistances (6) to the left of this board are also connected, one in each anode circuit of the rectifier. The transformer (7) which supplies the filament current to the rectifying valves, and the H.T. output smoothing choke (8) are mounted on the floor of the cubicle.

45. At the right of the lower cubicle are the holders (3) and (4) in which are carried the two rectifying valves which supply the H.T. to the amplifier, and on the floor of the cubicle beneath are mounted the transformer (11), which supplies the filament current for these valves, and the H.T. smoothing choke (10). In the centre of the floor of the cubicle is a board carrying ten 100,000 ohms resistances wired in series and connected across the output of the rectifiers. Three 500 milliamperce fuses, one of which (12) can be seen to the right of the valve-holder, are included in the rectifier circuits. One is connected in each of the anode circuits of the valves and one in the H.T. supply lead to the amplifier. The gate switch (13), which is closed only when the front panel is in position, can also be seen in this illustration. In fig. 8 can be seen the transformer (1) which provides the supply to the anodes of the rectifiers. The full voltage of the secondary is applied to the rectifiers supplying the amplifier, whilst the gas-filled rectifiers which supply the oscillator are supplied with a lower voltage from tappings on the secondary. The two 4 μ F condensers (3) are in the smoothing circuit of the gas-filled rectifiers and the two condensers (2) to the left of these are of the same value and are in the smoothing circuit of the amplifier rectifiers.

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The three mains relay switches can be seen mounted on an inner panel to the right. The upper relay (4) is the delay action relay (X_2 , fig. 2) and contains an escapement mechanism which delays the closing of the contacts for 30 seconds after the operating winding is energized from the A.C. mains. The winding of this relay is in series with the three gate switches (13, 15 and 16,

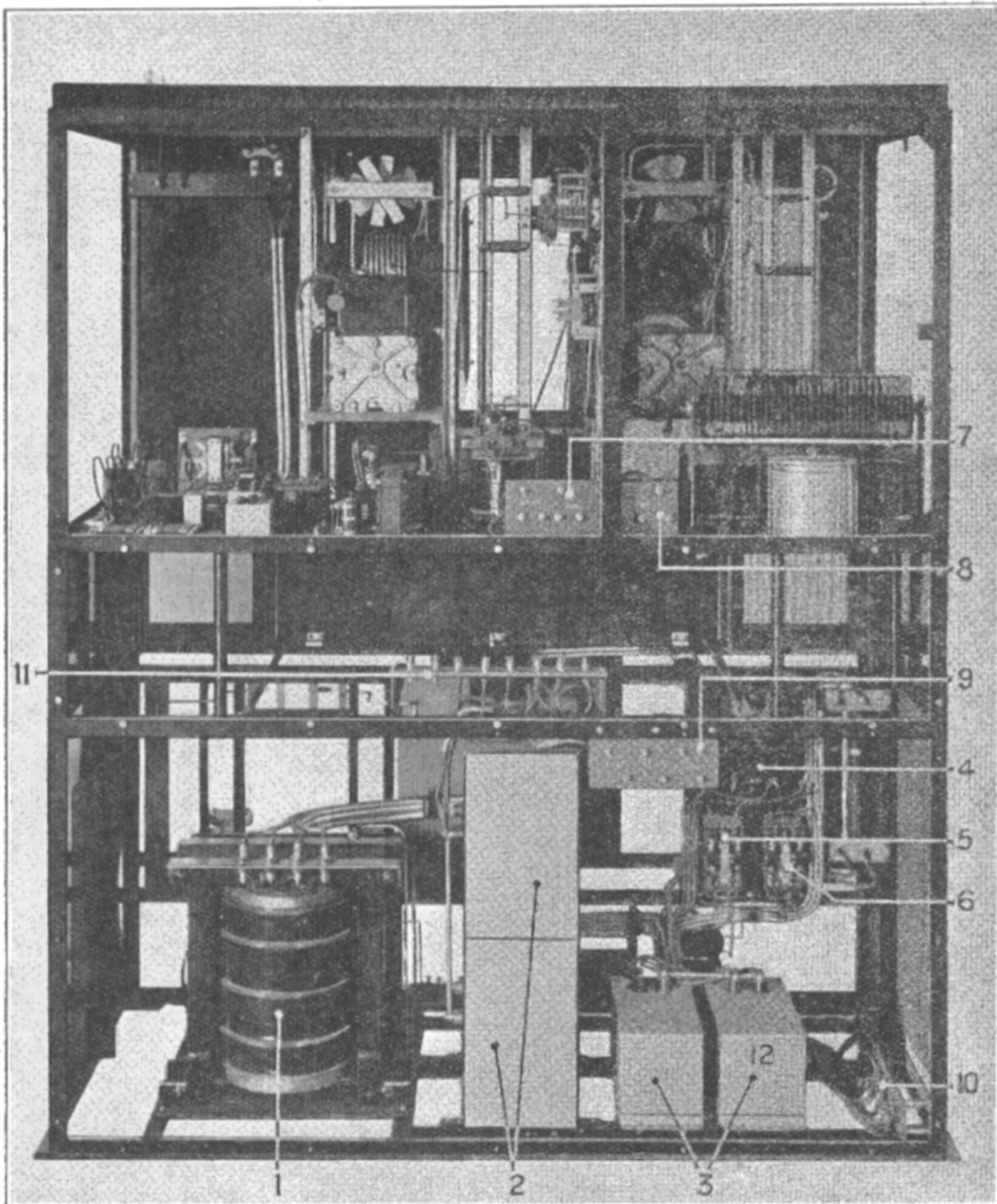


FIG. 8. Rear view, back removed.

fig. 9) so that it becomes de-energized and trips the contacts if a gate is opened. It will be energized again on closing the gates, but a further 30 seconds delay takes place before the operating contacts close. The operating contacts are in series with the A.C. supply to the primary of the H.T. transformer. Also in series with this supply are the operating contacts of the H.T. relay (5)

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so that it is necessary to have these contacts closed in addition to the gate switches, in order to complete the A.C. supply circuit to the primary of the H.T. transformer. The L.T. relay (6) has its contacts connected in series with the main A.C. line. The windings of the L.T. relay (6)

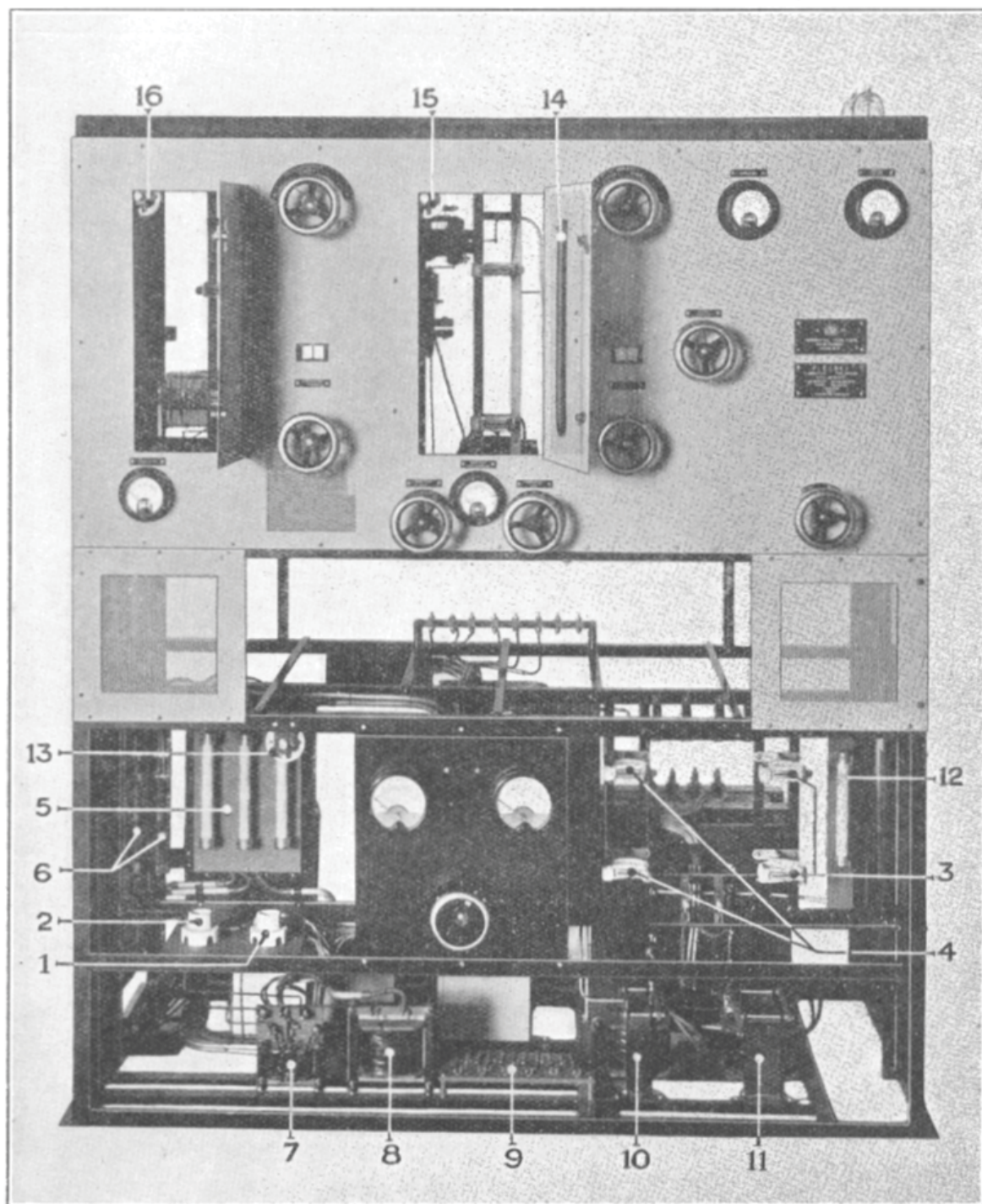


FIG. 9. Front view, lower cubicle uncovered.

and the H.T. relay (5) are connected across the A.C. supply only when the appropriate remote control switches are closed. The winding of the delay relay (4) is connected across the A.C. supply when all the gate switches are closed. There is no other control on this relay.

46. In fig. 10 is given a plan view of the lower cubicle. The upper cubicle, which is normally carried on four angle irons at the corners and six distance pieces (1), has been removed for this view. The four terminals on the top of the H.T. transformer (2) are the primary windings which are connected by lead-covered cable to the voltage regulating switch (15, fig. 1) on the front

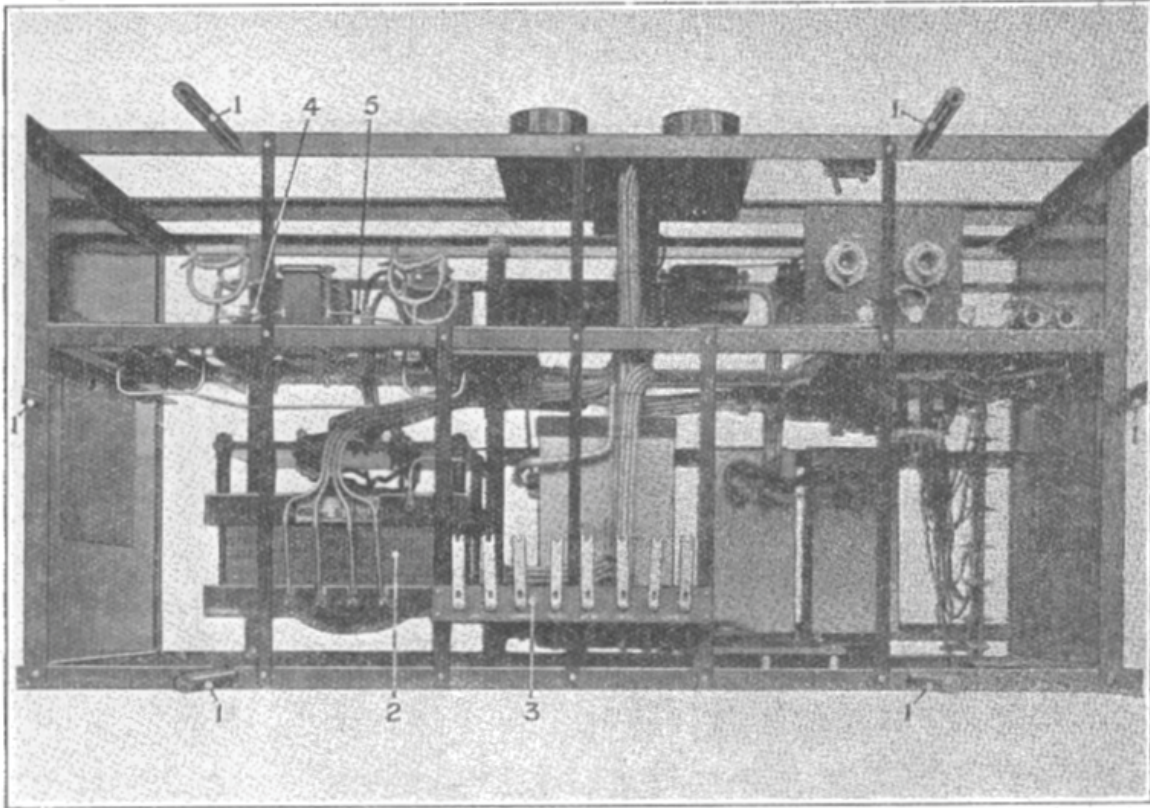


FIG. 10. Lower cubicle viewed from above.

of the panel. The terminal strip (3) is provided with eight links to enable convenient connections to be made to the remote control unit which is slid into position upon the upper framework of this cubicle. The remote control unit is provided with a similar terminal strip carrying eight terminals and similarly engraved.

VALVES

47. The valve used in the master-oscillator circuit is a T.X.3-200 with a filament voltage of 12. The valve used in the amplifier is a T.X.5-400 with a filament voltage of 17.5. The 1,000 cycle oscillator circuit employs an indirectly heated 164V. valve having a heater voltage of 4. The grid-leak modulator valve which is coupled to the 1,000 cycle oscillator circuit is an M.Z.05-20 valve. It has a filament voltage of 6.

48. The rectifying valves for the oscillator are gas-filled RG1-125 valves having filament voltages of 2, and the rectifying valves for the amplifier are R.X.3-120 valves, the filament voltage of which is 13.5. A D.W.4 double wave rectifying valve (4 volt filament) is used for supplying the H.T. for the 1,000 cycle oscillator, for the supply to the keying circuit, and for the amplifier grid bias.

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OPERATION

49. See that the 230 volt 50 cycle A.C. supply is connected up to the terminal board on the left-hand side of the lower cubicle, that the jumper connections between the two cubicles are properly connected and that the control line is connected up to the terminals marked A and B. The remote control unit, type 2, is provided with eight terminals which should be connected across by the eight strips provided to the remote control panel on the transmitter.

50. Connect up the transmission line or aerial to the appropriate insulators on the top of the transmitter. Place all valves in position. See that the anode circuits of the two thermionic rectifier valves (H.T. supply to amplifier) are broken by means of the straps (4 and 5, fig. 10) provided.

51. Close the L.T. switch on the remote control unit. This will complete the A.C. supply circuit to the filament transformers, and the valve filaments will heat up. Thirty seconds after the closing of the L.T. switch the delay relay will operate automatically. The gate switches are in series with the winding of the delay relay. The delay relay cannot, therefore, operate if any gate on the transmitter is left open. The H.T. circuit will not yet be completed as it is still broken at the H.T. relay, which can be closed only by operating the H.T. switch on the control unit. Before closing the H.T. switch, set the "power control switch" to position 3 (lowest voltage) and the C.W.—M.C.W. switch to the C.W. position. Set the aerial coupling to zero. Set the range switches (see Table 1) to give similar inductance ranges, e.g., master-oscillator to 1, amplifier grid to 1 and amplifier anode to 2. Now close the H.T. switch on the control unit. Observe the milliammeter in the oscillator anode circuit. There should be a reading of 50 to 80 milliamperes.

52. Press the test key and tune the amplifier grid circuit. The amplifier grid milliammeter should show a reading of 20 to 35 milliamperes. Whilst observing the grid milliammeter, vary the amplifier anode tuning condenser and ascertain the resonant setting.

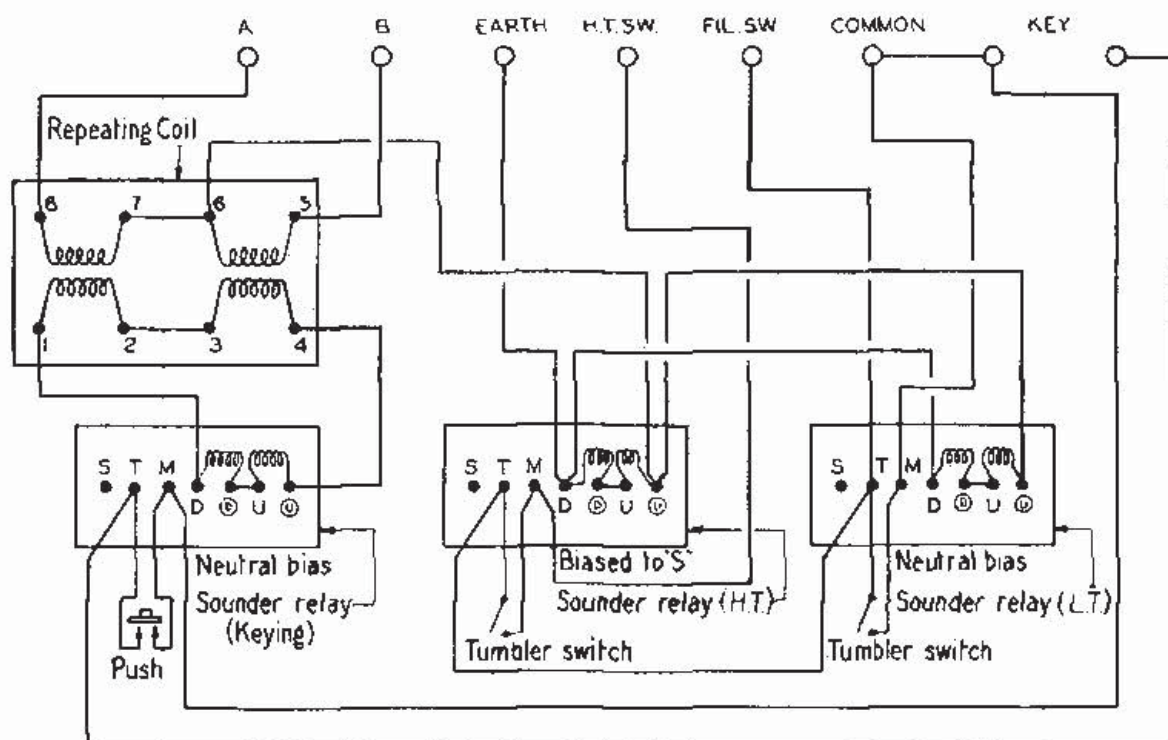


FIG. 11. Remote Control unit (type 2) circuit diagram.

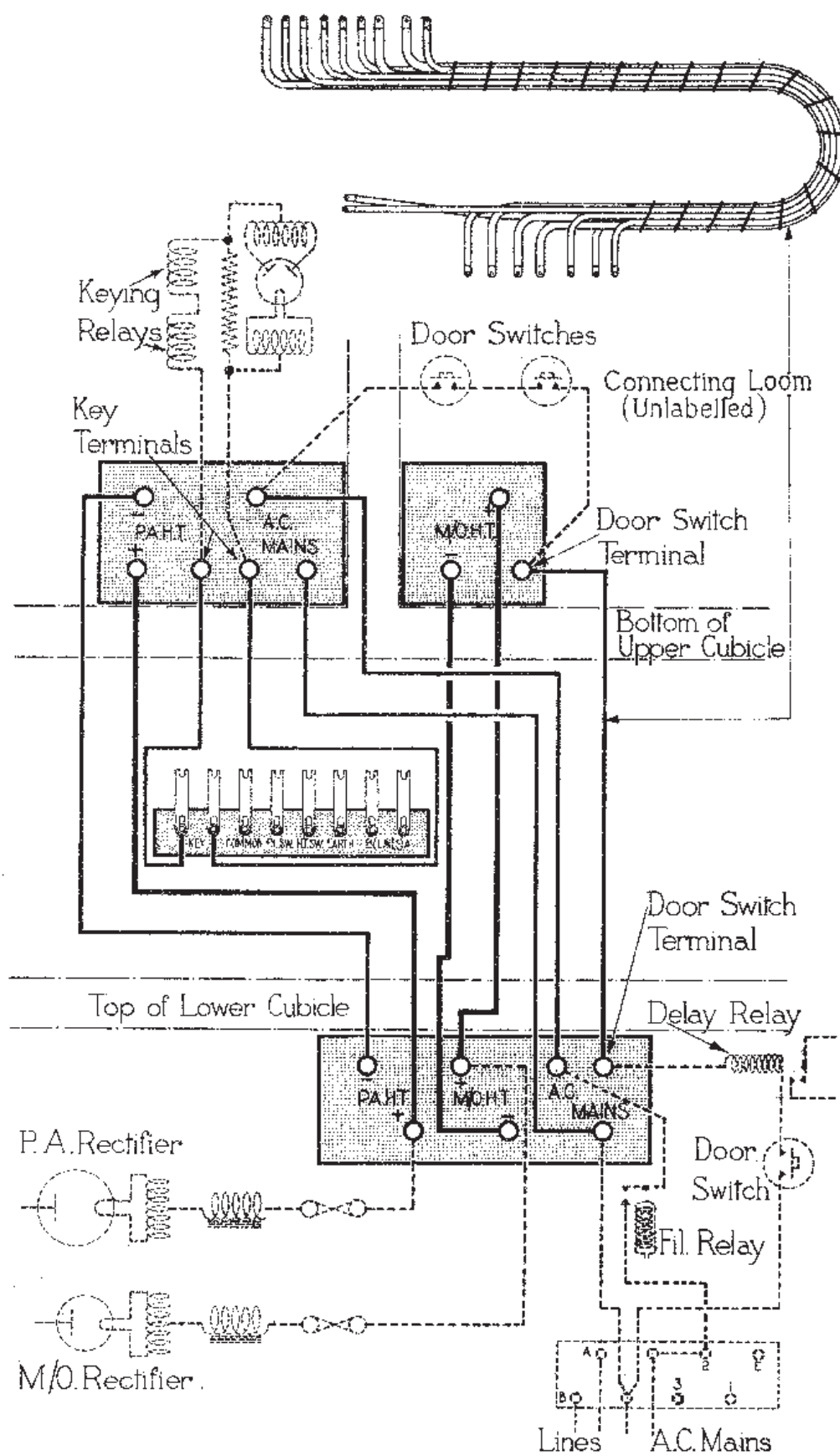


FIG.12. INTER-CUBICLE CONNECTIONS

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53. The amplifier should now be neutralized by inserting the special insulated tool (14, fig. 9) through the hole in the door of the amplifier section and engaging it with the neutralizing condenser spindle. Whilst varying the amplifier anode tuning control about the resonant point, adjust the neutralizing condenser until the "kick" on the grid milliammeter produced by the amplifier anode control is gradually reduced. The neutralizing condenser should be left at the adjustment which gives the minimum "kick."

54. Break the H.T. circuit by means of the switch on the control unit and re-connect the two links in the anode circuits of the thermionic rectifiers which supply the H.T. to the amplifier. Close the H.T. switch and check the neutralization, making any slight adjustment that may be necessary. Increase the aerial coupling and re-tune the amplifier anode circuit. The voltage may now be increased by moving the power control to position 2 and then to position 1.

55. The oscillator tuning condenser scale is calibrated directly in megacycles and if this is set to the frequency required the succeeding tuned circuit can be brought into resonance with it. In Table 2 is given a typical set of readings for several frequencies. For accurate setting of the frequency, however, a wavemeter such as W.1081 should be used or, failing this, a wavemeter W.66 may be used as a preliminary adjustment subsequently checking the frequency by reference to the monitoring station. The transmitter should be allowed to reach a steady temperature before finally setting the frequency, a warming-up period of at least 15 minutes being necessary.

PRECAUTIONS AND MAINTENANCE

56. When setting the transmitter to frequencies within the 5.3 to 3.0 megacycles band (range 3 of the master-oscillator) the 0.0005 μ F condenser in the master-oscillator cubicle must be brought into circuit by means of the link provided. The link must be opened for all other ranges. When connecting or disconnecting this link it should be remembered that although the H.T. circuit will be broken (the opening of the cubicle gate will trip the delay relay) the condenser and that adjacent to it will be holding a charge. The condenser should be short-circuited by means of a screwdriver or similar tool with an insulated handle before handling.

57. The rectifying valves (RG1-125) used for the oscillator supply are of the gas-filled type. If it should be necessary to insert a new one or one that has been out of use for some time, the filament should be heated for at least 15 minutes before H.T. is applied to the anode.

58. When inserting or withdrawing the master-oscillator valve, care should be taken to ensure that the compensating capacity device beside it is not interfered with. The two strips which comprise this device are bowed outward from one another and it is important that no change in the shape should be made.

59. All relays should be periodically inspected to see that they are free on their bearings, this applies particularly to the keying relays, a very small amount of clock oil being applied, if necessary. The relay contacts should be inspected at the same time and cleaned if necessary. Should any pitting be found the contacts should be faced up carefully with a magneto file. The relays which key the aerial circuit and the coupling link (11 and 8, fig. 7) are mounted on metal partitions of rather large area. If any trouble is experienced in the operation of the relays examine the mountings and partition bolts and take all precautions to ensure that all causes of excessive vibrations are removed. The time delay relay should have the escapement mechanism oiled with clock oil occasionally. All switch blades, contacts, valve-holder sockets, etc., should be inspected periodically and cleaned where necessary.

60. A resistance (R_8 , fig. 2) is provided across the reservoir condenser C_{18} in the amplifier rectifier supply. No such discharge resistance is provided on the M/O rectifier, and one should be fitted in order to protect personnel from shocks. This should be made up by soldering four

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resistances type 29 (Stores Ref. 10A/7267) in series, making short connections between the resistances to keep the assembly rigid. When fitting this the A.C. main switch should first be switched off and the lower rear cover of the transmitter removed. The two condensers (3, fig. 8) should now be discharged by means of a screwdriver with an insulated handle. The resistance assembly may then be connected across one of these condensers, making sure that the resistances are clear of all other conductors. The condenser in question is represented by 12, fig. 8. It will be seen that a connection is taken from this to the fuse F.3, and that the condenser is on the load side of the choke.

61. The usual form of remote control employed with ground station transmitters is of the A.C. keying type, and not the type described in paras. 29 *et seq.* The system of keying transmitters by means of A.C. is described in this publication in the chapter on remote controls and in order to adapt the T.1078 to this form of keying, a modification will be necessary. At the present time (1938) no such change is visualized.

TABLE 1

Frequency Megacycles.	Master- Oscillator Range.	Amplifier Grid Range.	Amplifier Anode Range.
15.0-12.0	1	1	1
12.2- 9.0	1	1	2
9.5- 5.25	2	2	3
5.3- 3.0	3*	3	4

* 0.005 μ F connected in M/O circuit for this range.

TABLE 2

kc/s.	Tunings.						Aerial Coup- ling.	M/O Input.		Amplifier Input.		Output C.W.	Power Tap.
	M/O.		Amplifier Grid.		Amplifier Anode.								
	Range.	Mc/s.	Range.	Condsr.	Range.	Condsr.		mA.	Volts.	mA.	Volts.	Amps.	
10,032	1	10.04	1	79	2	78	3.0	71	1,505	130	3,150	.52	1
10,032	1	10.04	1	79	2	78	3.0	60	1,340	106	2,790	.42	2
10,032	1	10.04	1	79	2	78	3.0	50	1,110	82	2,340	.32	3
10,032	1	10.04	1	72	2	78	3.0	77	1,600	74	3,500	.33	1
15,400	1	15.4	1	18	1	144	3.0	75	1,500	176	3,100	.60	1
12,000	1	12.0	1	57	1	2	1.5	76	1,840	156	3,190	.52	1
12,200	1	12.2	1	56	2	165	1.5	78	1,520	164	3,150	.66	1
8,900	1	8.9	1	92	2	15	1.5	75	1,570	130	3,300	.5	1
9,100	2	9.1	2	24	3	180	1.5	110	1,390	190	3,000	.64	1
5,100	2	5.1	2	87	3	3	1.5	135	1,310	200	2,800	.54	1
5,250	3	5.25	3	35	4	179	1.5	63	1,525	156	3,190	.64	1

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/8292	Transmitter, type T.1078		Complete, without valves.
	Principal components :—		
10A/9406	Ammeter, Thermo 0-1 amp.	1	2½ in. dial, projecting type.
10A/9390	Choke L/F.	1	Iron core 5 in. × 5 in. × 5½ in. overall (approx.).
10A/9391	Choke L/F.	2	Iron core. 4 in. × 5 in. × 5 in. overall (approx.).
10A/9392	Choke L/F.	1	Iron core 3½ in. × 4 in. × 3 in. overall (approx.).
10A/9375	Condenser	1	·002μF, 2,500 V.D.C. with porcelain cover.
10A/9376	Condenser	1	4,000μF, electrolytic, 12V. working.
10A/9377	Condenser	2	·0005μF, in moulded case.
10A/9378	Condenser	1	·00003μF, fixed air dielectric.
10A/9379	Condenser	1	·002μF, in moulded case.
10A/9380	Condenser	2	2·0μF, 500 V. paper dielectric, metal case.
10A/9381	Condenser	1	·15μF, 250 V. paper dielectric, metal case.
10A/9382	Condenser	2	2·0μF, 250 V. paper dielectric, metal case.
10A/9383	Condenser	2	1·0μF, 250 V. paper dielectric, metal case.
10A/9384	Condenser	2	4·0μF, 2,500 V. paper dielectric, metal case.
10A/9385	Condenser	2	4·0μF, 4,000 V. paper dielectric, metal case.
10A/9386	Condenser	2	Variable, ganged air dielectric.
10A/9387	Condenser	1	·002μF, moulded case.
10A/9388	Condenser	1	Adjustable air condenser.
10A/9389	Condenser	1	·0002μF, variable, air dielectric.
10A/9185	Condenser, type 286	3	·01μF.
10A/9393	Fuse, 350 mA., 2,000 V.	3	
10A/9394	Fuse, 500 mA., 3,000 V.	3	
10A/9395	Inductance	1	Oscillator anode.
10A/9396	Inductance	1	Amplifier grid.
10A/9397	Inductance	1	Amplifier anode.
10A/9398	Inductance	1	Aerial.
10A/9399	Inductance	3	{ Oscillator grid choke. Amplifier grid choke. Amplifier anode choke.
10A/9400	Inductance	1	
10A/9401	Inductance	1	{ 1,000 cycle oscillator.
10A/9402	Inductance	1	{ Combined unit.
10A/8093	Insulator, Type 16	2	
10A/9404	Milliammeter 0-50 mA.	1	2½ in. dial, projecting type.
10A/9403	Milliammeter 0-250 mA.	1	2½ in. dial, projecting type.
10A/9405	Milliammeter 0-300 mA.	1	2½ in. dial, projecting type.
10A/8409	Rectifier, metal	1	
10A/9410	Relay, magnetic	2	S.P. make and break, A.C. operated.

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APPENDIX—continued

Ref. No.	Nomenclature.	Quantity.	Remarks
10A/8292	Transmitter, Type T.1078— <i>continued</i>		
	Principal components— <i>continued</i>		
10A/9411	Relay, magnetic	1	H.T. relay with time lag mechanism. A.C. operated.
10A/9412	Relay, magnetic	2	Keying relay 600 V. D.C. operated.
10A/9413	Resistance	2	125 ohm, 30 watt, vitreous embedded.
10A/9414	Resistance	8	1,000 ohms, rod type 43 × 6 mm.
10A/9415	Resistance	3	2,500 ohms, rod type 43 × 6 mm.
10A/9418	Resistance	12	1,000 ohms, rod type 43 × 6 mm.
10A/9419	Resistance	10	100,000 ohms, 1 watt, rod type.
10A/9420	Resistance	2	1,400 ohms, 150 watts, vitreous embedded, with two taps.
10A/9421	Resistance	1	300 ohms, $\frac{1}{2}$ watt, rod type.
10A/9416	Resistance	2	2,000 ohms, 30 watts, vitreous embedded.
10A/9422	Switch	1	Oscillator range switch.
10A/9423	Switch	1	Amplifier grid switch.
10A/9424	Switch	1	Amplifier range switch.
10A/9425	Switch	1	C.W. and M.C.W. switch.
10A/9426	Switch	1	Power control switch.
10A/9417	Terminal panel, remote control ..	1	
10A/9427	Transformer	1	M/O Fil. R.M.T.33.
10A/9428	Transformer	1	Amplifier Fil. R.M.T.24.
10A/9429	Transformer	1	Oscil. "Mod" Fil. R.M.T.34.
10A/9430	Transformer	1	Bias Rectr. Fil. R.M.T.13.
10A/9431	Transformer	1	Mercury Rectr. Fil. R.M.T.28.
10A/9432	Transformer	1	H.T. Foster 71/S.202.
10A/9433	Transformer	1	Thermionic Rect. Fil. R.M.T.26.
10A/9434	Transformer	1	G.L. Modr. Fil. R.M.T.10.
10A/9407	Voltmeter 0-2.5 kilo-volts	1	3 $\frac{1}{2}$ in. dial, projecting type.
10A/9408	Voltmeter 0-4.0 kilo-volts	1	3 $\frac{1}{2}$ in. dial, projecting type.
	<i>Accessories</i>		
10A/9009	Controls, remote, ground station, Type 2 ..	1	
10A/9435	Valve T.X.3-200	1	M/O Mullard.
10A/9436	Valve T.X.5-400	1	Apmr. Mullard.
10A/9437	Valve 164 V	1	M.C.W. Oscillator Mullard.
10A/9438	Valve M.Z.05-20	1	G.L. Modr. Mullard.
10A/9439	Valve D.W.4	1	Bias Rectr. Mullard.
10A/9440	Valve R.G.1-125	2	Mercury Rectr. Mullard.
10A/9411	Valve R.X.3-120	2	Thermionic Rectr. Mullard.

December, 1938

AIR PUBLICATION 1186

Volume I

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TRANSMITTER T.1083

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TRANSMITTER T.1083

(Stores Ref. 10A/8456)

INTRODUCTION

1. This transmitter is a General Purpose Aircraft Transmitter covering the following frequency bands 136 to 500 kc/s and 3 to 15 Mc/s. It is capable of C.W., I.C.W. and R/T transmission. The send-receive switch of the transmitter may be remote controlled.

2. The transmitter comprises a master-oscillator valve and an amplifier valve, the frequency bands being covered in four ranges by means of four pairs of plug-in coils. The ranges are as follows : 136 to 500 kc/s, 3 to 6 Mc/s, 6 to 10 Mc/s and 10 to 15 Mc/s. C.W., I.C.W. or R/T

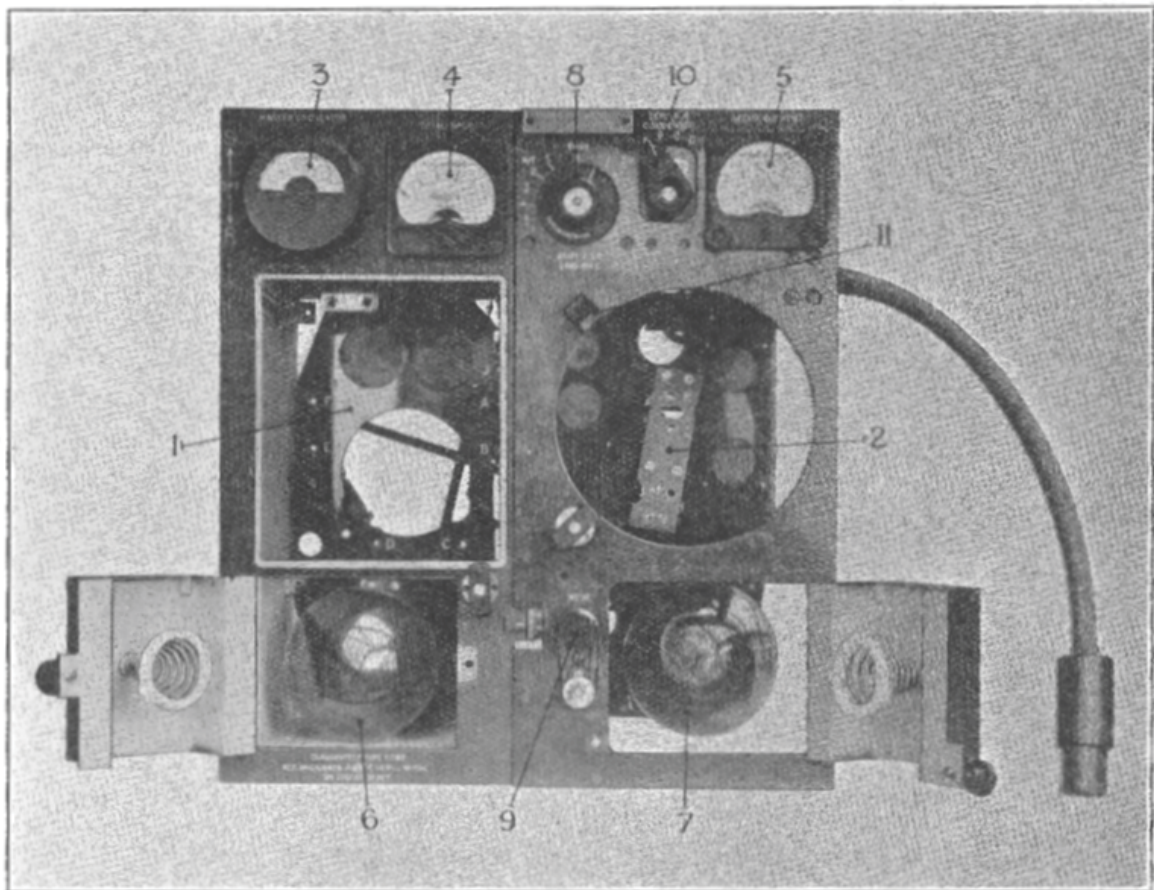


FIG. 1. Front view of transmitter, T.1083.

transmission may be made on any of these ranges, except the first mentioned range, where R/T is not practicable. The transmitter is intended to be used in conjunction with the receiver R.1082 and arrangements are provided to enable the transmitter and receiver to be used for intercommunication in the aeroplane. Provision is also made for "listening-through".

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GENERAL DESCRIPTION

Transmitter

3. In fig. 2 is given a theoretical circuit diagram of the transmitter. V_1 is an amplifier valve and V_2 an oscillator valve. The plug-in units for both amplifier and oscillator may be changed to cover the frequency bands required. There are four of these units for the oscillator and four for the amplifier, marked as follows:—

Range A	..	..	10–15 Mc/s
„ B	..	..	6–10 Mc/s
„ C	..	..	3–6 Mc/s
„ D	..	..	136–500 kc/s

4. In the diagram of fig. 2 the circuit is shown for the 3–10 Mc/s band (ranges B and C). The circuit changes effected when coil units A or D are plugged into position are shown in the dotted rectangles near the oscillator and amplifier valves, and the resistance and capacitance values are given in the table in the upper right-hand corner of the illustration.

5. A switch is provided on the transmitter by means of which one, two or three small condensers may be included in the aerial circuit to raise its natural frequency. Position A gives the highest, and position D the lowest, natural frequency.

6. External to the transmitter a further condenser may be connected in the earth lead when, in a large aircraft, difficulty is experienced in reaching the highest frequencies. This condenser is shunted by an inductive resistance so that no steady charge can accumulate. Such a charge would raise the chassis of the transmitter to a potential other than earth potential. An aerial blocking condenser is provided.

7. The neutralizing winding L_4 in the amplifier circuit is provided to prevent feed-back in the amplifier circuit. If this provision were not made the value of the master-oscillator drive would be lost. The winding is connected back to the grid of the amplifier through the fixed condenser C_5 and the variable condenser C_6 , and neutralization is effected by adjustment of the condenser C_6 . The fixed condenser C_5 is connected in series to prevent damage in the event of an accidental short-circuit in the variable condenser.

8. Keying is effected by joining H.T. negative to L.T. negative through the bias as shown in fig. 7. It will be seen that the oscillator is keyed as well as the amplifier.

9. For R/T, modulation is effected by connecting the secondary of a microphone transformer in series with the amplifier grid-bias arrangement. There is thus imposed on the steady grid bias a component which alternates at speech frequency.

10. In fig. 3, simplified diagrams are given showing the changes in the circuit of the transmitter for the frequency bands 15–10 Mc/s (range A), 10–3 Mc/s (ranges B and C) and 500–136 kc/s (range D). Referring first to range D it will be seen that on the lower frequencies the master-oscillator circuit is a Colpitts oscillator in which reaction is obtained by applying the R/F. p.d.'s of the mains condenser between grid and filament. The inductance is tapped and a fine tuning variometer is included. The amplifier circuit incorporates a tapped coil and fine tuning variometer. The coupling between amplifier and master-oscillator is through a coupling condenser. A neutralizing arrangement is not provided on this frequency band.

11. For ranges B and C it will be seen that the oscillator becomes a tuned-anode-tuned-grid circuit in which reaction is obtained through the anode-grid capacitance of the valve. The anode inductance is shunted by a condenser through a variable tapping point. The grid circuit is tuned by a variometer. The amplifier circuit incorporates an inductance with a variable aerial tap and a neutralizing winding. The coupling between amplifier and master oscillator is provided by the coupling coil.

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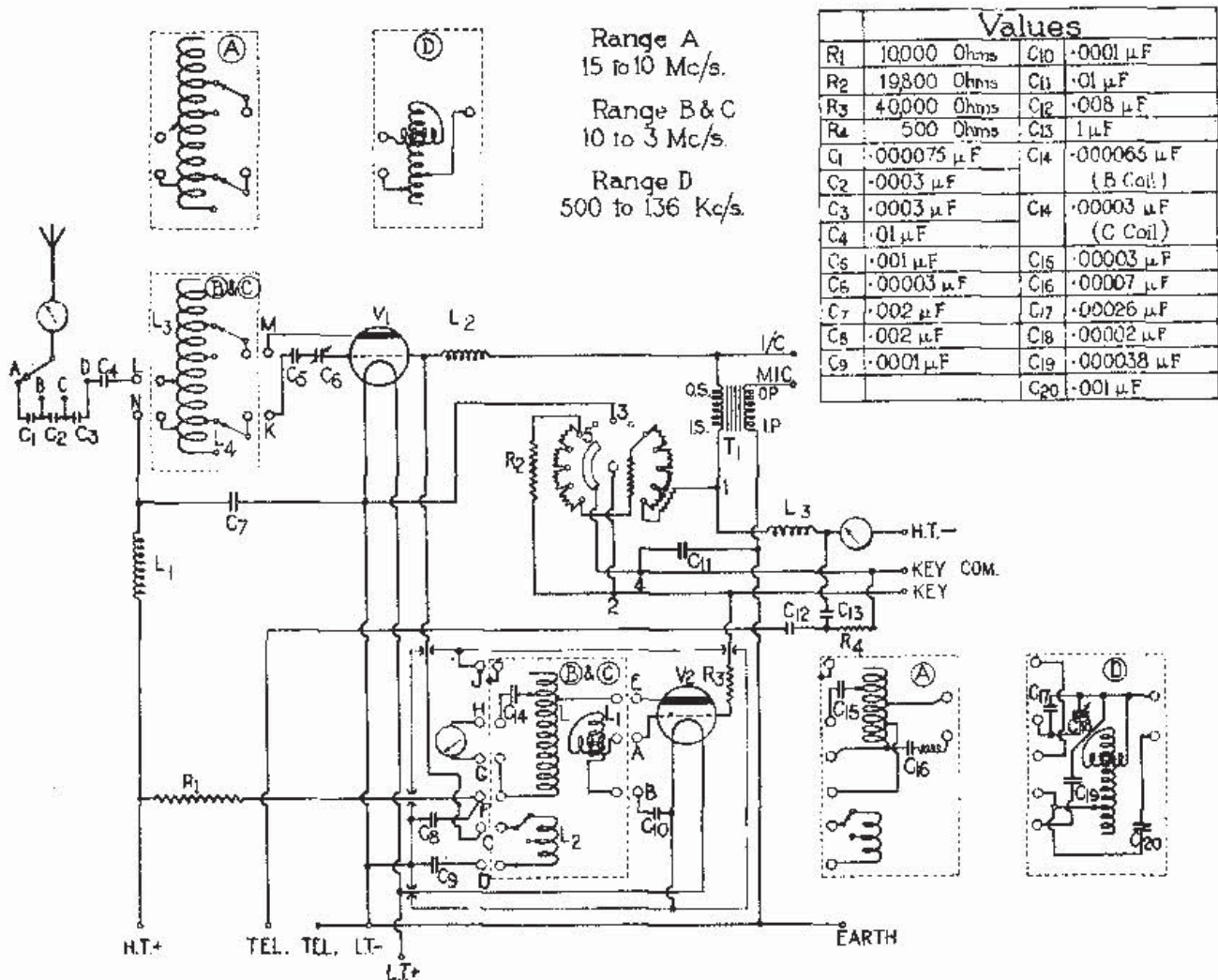
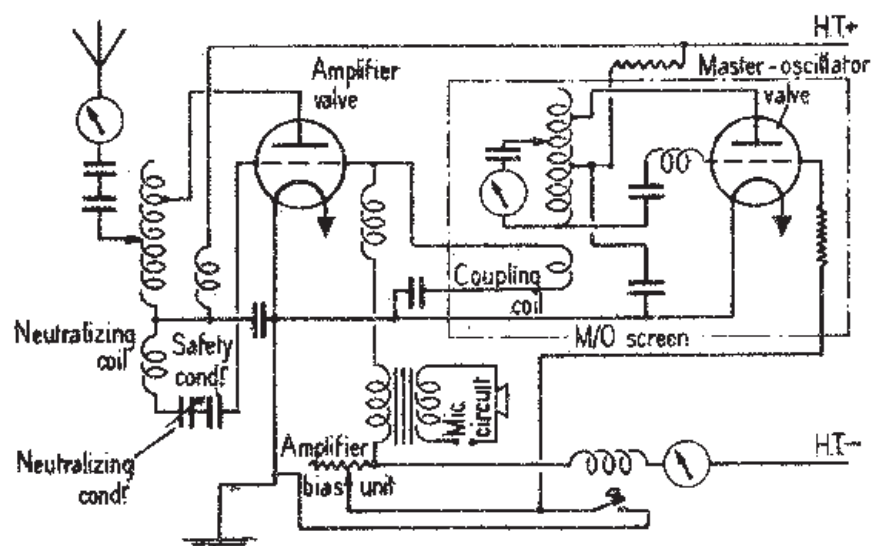
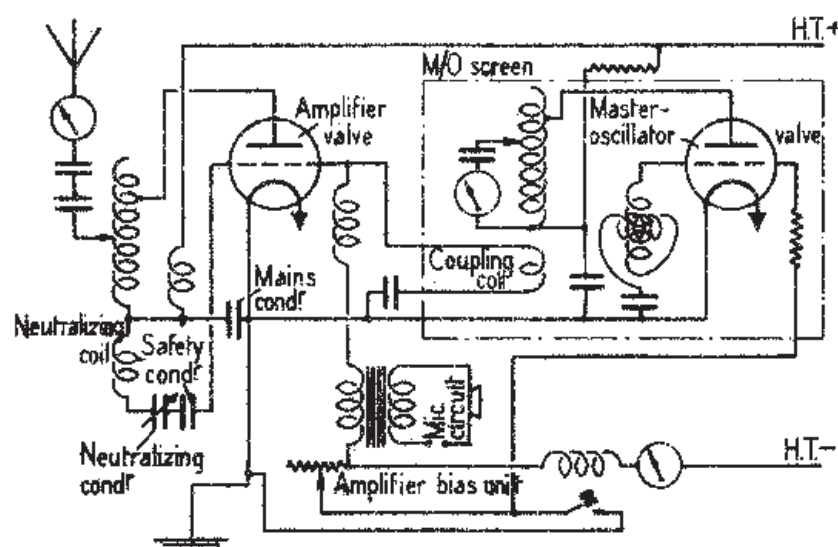


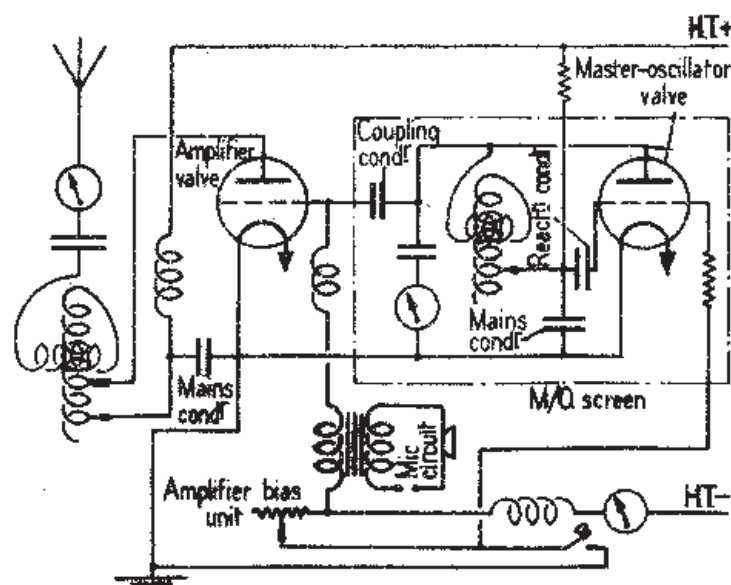
FIG.2, THEORETICAL CIRCUIT DIAGRAM



15-10 Mc/s (RANGE A)



10-3 Mc/s (RANGES B & C)



500-136 kc/s (RANGE D)

FIG. 3. SIMPLIFIED CIRCUIT DIAGRAMS T.1083

12. For range A the amplifying circuit remains the same as for B and C (an inductance with a variable aerial tap and a neutralizing winding) but the master oscillator circuit is now changed to a form of Hartley circuit, the anode inductance being shunted by a condenser through a variable tapping point, and the grid circuit being coupled to the end of the inductance through a choke and condenser.

13. The way in which grid bias is controlled is shown in fig. 7. A suitable fraction of the resistance $R+R_2+R_1$ is connected between H.T. negative and filament, and the IR drop across this resistance is used as grid bias. The resistance R is always in circuit; it ensures that the bias will never fall below a safe minimum value. The arm selects a tapping on resistance R_2 and includes a suitable fraction of R_2 in series with R. When the arm is moved into the position "TUNE" the resistance R_1 is put in series with R and R_2 . In this position the bias is so great that the amplifier valve is inoperative.

14. The arm has ten positions on R_2 , marked C.W. 1, 2, 3, 4 and 5 and R/T 1, 2, 3, 4 and 5 respectively. As the arm is moved from stud 1 to stud 5 in either the C.W. or the R/T quadrant the bias is progressively decreased, and the input and output of the amplifier are correspondingly increased. When the arm is moved into any of the five R/T positions it not only selects a suitable steady bias but also short-circuits the key. The bias for the oscillator valve is fixed by means of a separate resistance.

15. In fig. 2 can be seen the arrangements for obtaining side tone. A portion of the audio-frequency component of the amplifier grid voltage is applied *via* a condenser C_{13} to a resistance R_4 to which the telephones are connected in series with a small condenser C_{12} . The telephones are switched from this circuit to the receiver by means of the send-receive switch, when reception is taking place. Also in fig. 2 can be seen the R/F. chokes in the transmitter H.T. + and H.T. - connections, and in the lead from the grid of the amplifier valve to the microphone transformer. The chokes in the H.T. leads are for the purpose of preventing R/F. energy from reaching the generator, and also to prevent any tendency for this circuit to resonate. The choke in the grid circuit ensures that the R/F. drive from the oscillator is not short-circuited *via* the microphone transformer and the bias circuit.

16. The chokes exterior to the transmitter can be seen in fig. 7. They are in the following circuits: H.T. + and H.T. -, key and microphone, and are grouped in one unit.

17. Transmitter filament chokes (Stores Ref. 10A/8463) are provided for use in flying boats, where the filaments are heated from a 12-volt battery; the D.C. drop in the chokes is 4 volts. If the battery is on charge (14 volts), the choke terminals marked L.BATT. should be used. The standard arrangement is shown in fig. 15, however, and no departure should be made from this without authority.

Coils

18. Six of the eight coil units with which the transmitter is provided are shown in fig. 4. The coil units in the front row are the M/O. units for ranges B, C and D covering the ranges 10,000 to 6,000 kc/s, 6,000 to 3,000 kc/s, and 500 to 136 kc/s respectively. The units in the rear row are the units for the corresponding ranges of the amplifier. Coil units range A (not shown) for both M/O. and amplifier are of similar appearance and cover the band 15,000 to 10,000 kc/s. All coil units are engraved with their frequency band. A diagram of the internal connections of the coils is given in fig. 13.

Listening-through

19. The installation is provided with a listening-through arrangement. This consists of a small unit of moulded material provided with three connections. Two of these connections are taken to the transmitter, and one to the receiver. When they are connected in this way a fixed

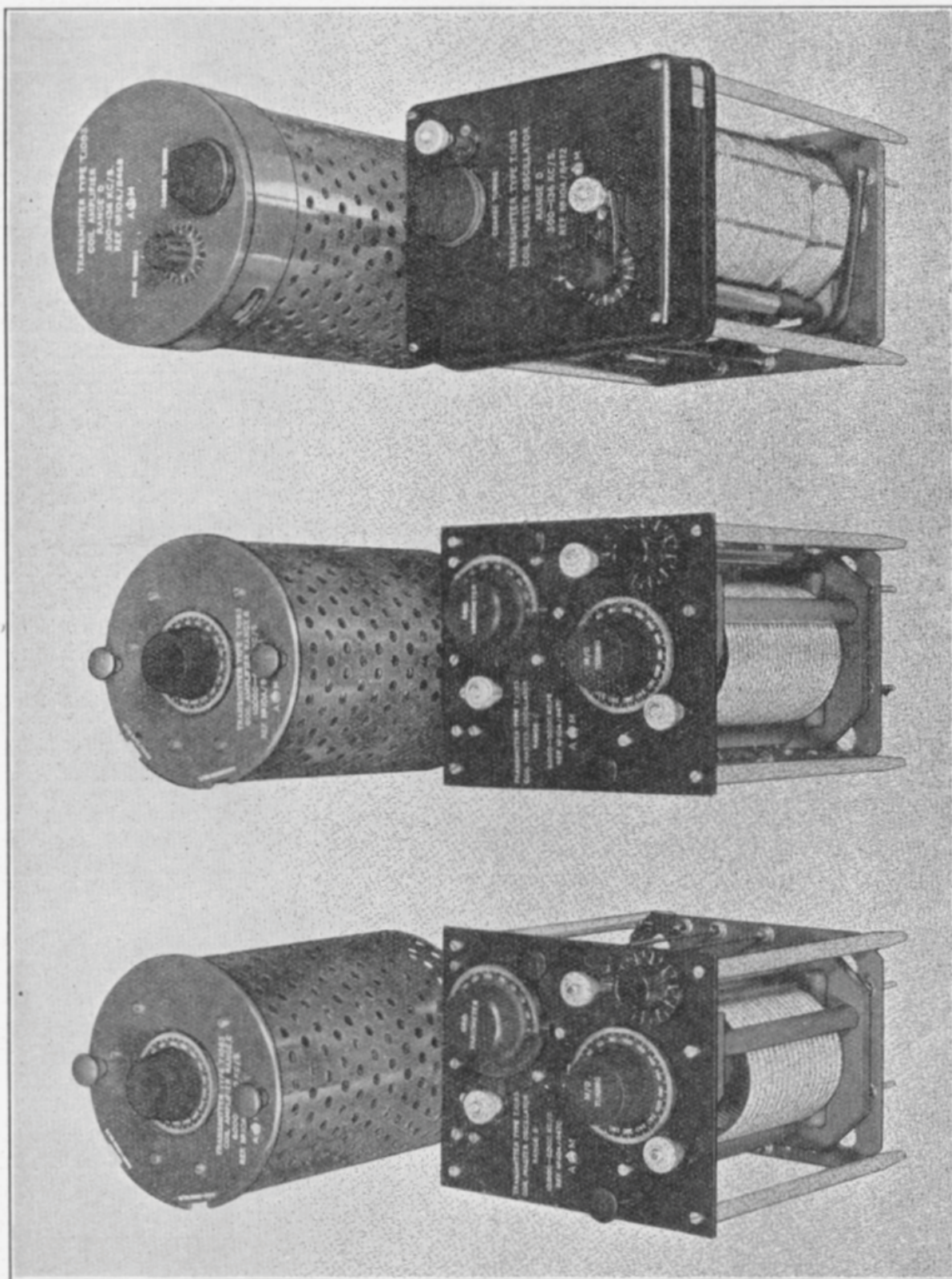


Fig. 4. Transmitter coils, B, C & D.

condenser incorporated in the unit is connected between the receiver and transmitter inductances, and the aerial is connected to one side of the condenser. As will be seen from the diagram of fig. 5, when transmission is in progress, the operator will be able to listen-in during pauses in his transmission owing to the permanent connection of the receiver through the listening-through condenser to the aerial. There is a further important effect arising from this listening-through arrangement. During reception, the transmitter aerial inductance (tuned to the same frequency) is coupled to the receiver aerial inductance, resulting in an increase of sensitivity and selectivity beyond those normal to the receiver. It will be apparent from the foregoing that background noises during reception would nullify any advantages derived from this and, therefore, it is essential that the generator should be as noise-free as possible. The smoothing unit shown in figs. 15 and 16 is, therefore, employed.

20. Listening-through is not possible when transmitting R/T. On telegraphic transmission it is only applicable when transmission and reception are being carried out on the same frequency. Searching is not practicable when listening-through. If it is desired to make use of the advantages accruing from the use of the transmitter aerial coil, and neither transmission nor searching is contemplated, it is important to ensure that the send-receive switch is in the "receive" position in order to avoid waste of L.T. current on the transmitter valve filaments.

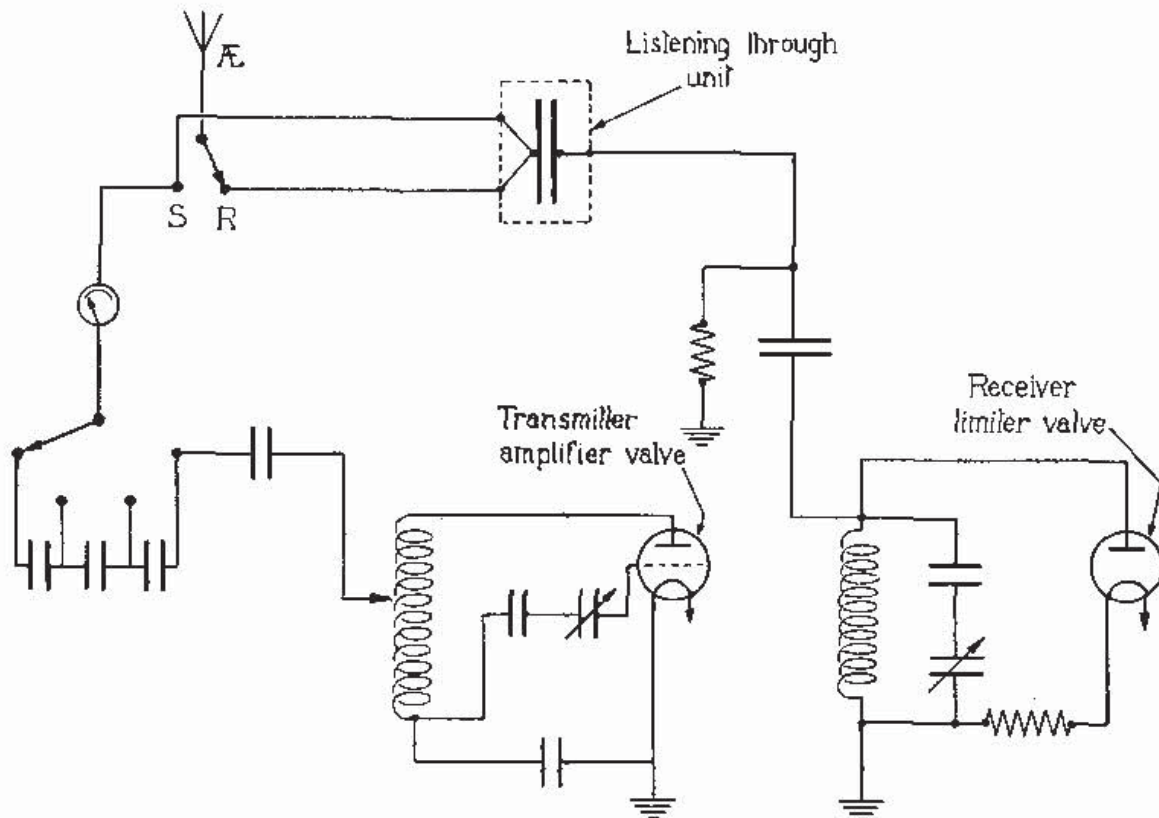


FIG. 5. Simplified listening-through circuit.

21. Owing to the use of plug-in connections on the listening-through unit, it is possible to re-arrange the connections to give "free receiver". By removing the receiver aerial connection (milled plug) from the unit and mating it with the milled socket (see fig. 7), the receiver is connected directly to the send-receive switch, and operation of the switch now merely changes the aerial from transmitter to receiver or *vice versa*.

22. When the receiver is connected up *via* the listening-through unit, and transmission is in progress, R/F. voltages will be developed across the transmitter aerial coil and applied *via* the listening-through condenser to the receiver input circuit. To avoid damage to the receiver

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a limiting valve is employed. This is a diode connected across the receiver input circuit. During alternate half cycles it acts as a low resistance across the receiver input, and any energy which the latter has accepted from the transmitter is harmlessly dissipated at the limiter valve anode. This protection is afforded only when the receiver switch is on. In order to ensure that the valve does not damp the receiver during normal reception, a small negative bias is applied to the limiter valve.

Remote controls

23. The arrangement of the remote controls for the T.1083-R.1082 installation is shown in fig. 6. The "control, switch and tuning" (1) has two handles, the upper one being engraved SEND-RECEIVE and the lower one being engraved TUNING. Movement of these handles is transmitted, through flexible shafts sliding in casings (2), to the send-receive switch (3) on the transmitter and the tuning control (4) on the receiver respectively. The internal flexible shafts (5) comprise a core of stranded steel wire on which is wound a spiral "tooth" wire, making approximately 10 turns to the inch.

24. In the controller is a "gear wheel" (6) which engages with the spiral tooth winding so that rotation of the gear wheel moves the shaft backwards or forwards in the casing. On the send-receive switch and tuning control of the instrument are coupling units similarly provided with gear wheels which are engaged with the spiral windings on the flexible shafts. The movement of the flexible shafts thus rotates these gear wheels operating the send-receive switch and tuning controls. The remote controls are permanently installed in the aeroplane and means are provided for easily releasing them from the instruments when the latter are removed from the aeroplane.

25. The outer casing is of solid drawn light aluminium alloy for the greater part of its length, but the portion (7) near the instrument is flexible, being constructed from a spiral brass strip, over which are two windings, one of steel wires and one of phosphor-bronze or spring steel, with an outer weatherproof covering of cotton braid treated with transparent varnish. The junctions between the rigid and flexible casing are made by unions (8).

26. The switch coupling consists of an aluminium body in which is a gear wheel, the spindle of which projects and carries an exterior handle (9). On the underside of the gear wheel is a dog coupling which engages with the fitting on the end of the send-receive switch spindle. The body of the switch coupling is provided with a split-ring and clamping bolt (10), and when fitting the switch coupling to the transmitter, the dog is engaged with the fitting on the send-receive switch spindle and the body is secured to an adaptor ring (11) on the transmitter by means of the split-ring and clamping bolt. Provision is made for different positions of the switch coupling to suit possible different angles at which the remote control shafts may enter. It is positioned by a projection on the underside of the switch coupling body which may be engaged in any one of 8 slots around the periphery of the adaptor ring. The handle may also be fitted in any one of 8 positions by undoing a slotted screw, removing the handle from the squared spindle and re-fitting.

27. Remote control of the tuning on the R.1082 is accomplished by varying the permeability of the anode inductance coil S.50. A square hole is provided in the movable element of the coil. In this is engaged a square spindle (12) carried in the coupling tuning which is, in turn, fitted on the pedestal coupling (13) fitted to the receiver. The coupling tuning is secured to the pedestal coupling by a split-ring and clamping bolt (22). A gear wheel (20) in this coupling is rotated by the to-and-fro motion of the flexible shaft causing the core to be inserted or withdrawn according to the direction of rotation. A spring plunger device (14) on the top of the coupling provides a means of disengagement. Disengagement is effected by pressing in the plunger after which the knob is rotated to obtain the correct tuning and then released. Operation of the remote tuning control, which has previously been set in a central position, now varies the tuning either side of a given point.

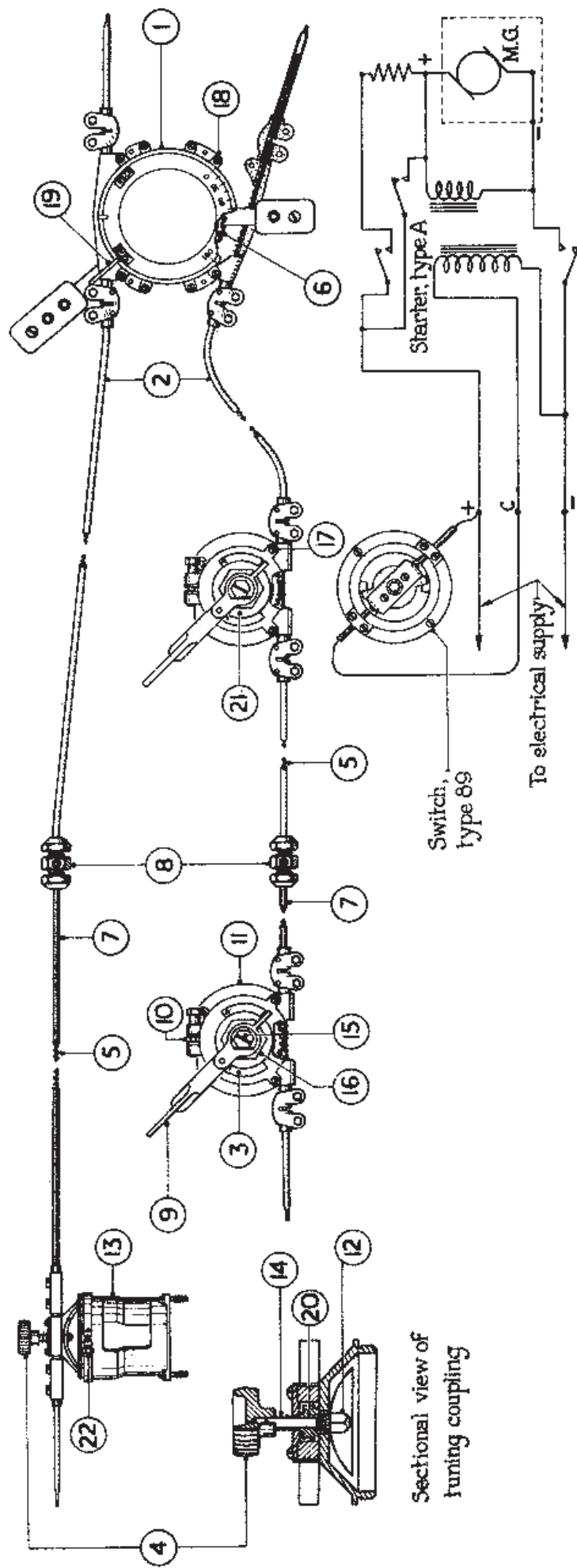


FIG. 6, REMOTE CONTROLS

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28. At one or more intermediate points on the send-receive shafting provision may be made, by means of additional switch couplings, to operate the send-receive switch. One of these (21) is provided with a remote switch (switch type 89) which is a simple "on and off" switch connected up to the motor-generator starting switch to ensure that the motor-generator starts up whenever the send-receive switch is placed in the send position and is stopped when the switch is placed in the receive or off position.

29. It is essential that the remote control mechanism be so adjusted that the controls on the instrument always occupy their correct positions when moved by, and as indicated on, the remote controller. The method of adjusting the controls is described in the following paragraphs.

30. At the instrument end, the dog of the switch coupling is engaged with the send-receive switch fitting and the body of the switch is secured to the adaptor ring by tightening up the clamping bolt. The switch is placed in the send position and the handle correctly positioned with respect to the indicating plate. The handle may be removed from the spindle by undoing the screw (15) and may be refitted in any one of eight positions. By undoing the nut (16) the indicating plate may be removed and refitted in any one of sixteen positions.

31. The intermediate switch coupling should now be disengaged from the internal shafting by undoing one of the screws (17) and swinging away the body of the switch coupling. Leaving this disengaged the controller end should now be set by undoing one of the screws (18) and swinging away the body of the controller so that the internal shafting is disengaged from the gear wheel. The control send-receive handle is now moved into the send position, but before re-engaging the wheel with the internal shafting, the latter should be tensioned by grasping the projecting end in the hand and pulling. Whilst maintaining the shafting in tension the body of the controller should be swung back again into position so that the gear wheel is again engaged with the flexible shafting and the screw (18) re-inserted. The intermediate switch coupling may now be placed in the send position, the wheel engaged with the shafting and the screw (17) re-inserted. Rotation of the controller handle should now result in the rotation of the send-receive switch and the intermediate switch coupling. To obtain correct synchronism a further slight adjustment may be necessary on the intermediate switch coupling. This may be made by locking the controller handle in the intermediate or off position with the catch (19) in the slot provided. If it is found on examination that the intermediate coupling switch is not exactly central, it should be disengaged and the wheel rotated a tooth or so either way to bring it exactly to off, and then re-engaged. It is important to check that the position of the switch type 89, coupled to the underside of the intermediate switch coupling is correct. In the send position it should be closed and in the off and receive positions it should be open. Two leads are taken from this switch to the starter type A, which is a relay starting switch for the motor-generator.

32. The relay starting switch consists of two electro-magnetic switches, one being double-pole and the other single-pole, and a resistance element of 0.22 ohm. When the switch type 89 is closed the solenoid operating the double-pole switch is energized from the 12 volt aircraft supply. Both contacts close, and the supply is connected across the motor-generator (the resistance being in series with the L.T. armature), and the motor-generator starts up. The solenoid of the single-pole switch is connected across the L.T. armature of the motor-generator and as the motor-generator speeds up, the voltage across the armature increases. When it reaches about 8 volts the single-pole switch closes and short-circuits the series resistance element thus allowing the motor-generator to run up to full speed. To stop the motor-generator the switch type 89 is opened. This de-energizes the solenoid of the double-pole switch breaking both sides of the supply to the motor-generator.

33. The tuning handle on the controller is provided with disengaging devices similar to those on the send-receive handle. The adjustment is facilitated by the provision of the spring plunger device on the receiver coupling tuning. It is only necessary to fit the pedestal coupling on the

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receiver and the coupling tuning on this with the square spindle on the latter engaged in the square hole in the movable element of the coil and ensure that the internal shafting is positioned so as to allow for rotation of the gear wheel on the coupling tuning over the full travel of the tuning handle.

34. Final adjustments of the tuning control are made with the receiver in operation. The tuning handle on the controller is set to the central position. The spring plunger is depressed, disengaging the spindle from the gear wheel, allowing the spindle to be turned freely. The movable element of the coil may thus be rotated until the correct tuning is obtained. The plunger is now released, allowing the spindle to be re-engaged with the gear wheel. Movement of the controller tuning handle now gives variation of the tuning on either side of a given frequency. It is important when installing the shafting to ensure that the flexible portion is cleared up as near the instrument as possible. If this is not done movement of the outer flexible casing takes place and unnecessary friction is produced when the controls are moved.

Artificial aerial, type 1

35. When a new transmitter is drawn from stores and installed in an aircraft one of the important things to be done is to set up the transmitter on all the operational frequencies which are likely to be used. When using a fixed aerial for transmission, *i.e.* for frequencies above 3,000 kc/s, the initial setting-up can be done conveniently in the aircraft on the ground, but when a long trailing aerial is used for transmission, *i.e.* for medium frequencies, the initial setting-up on operational frequencies cannot be done conveniently in this way, but it may be done by using the artificial aerial as a load.

36. The artificial aerial consists of a resistance and a variable capacitance and simulates the aircraft aerial. The capacitance of a trailing aerial varies with its length and with the type of aircraft and, possibly within small limits, with different aircraft of the same type. With a 250 ft. length of aerial, the capacitance may be expected to vary between 200 and 300 μF , depending on the size of the aircraft and the method of construction. The artificial aerial may be set to some intermediate value as a compromise, for the initial bench setting-up of the transmitter. Since the amplifier settings in the air may differ quite considerably from those obtained on the bench, a method is employed whereby the artificial aerial may be matched to the trailing aerial of a particular aircraft for a particular frequency.

37. This method may be described in the following way. The M/O settings and the final amplifier setting obtained in the air, for a particular frequency, are ascertained. On the ground these readings are set on the transmitter, which is then operated into the load of the artificial aerial, the latter having first been adjusted to an approximate setting. The artificial aerial is then tuned until minimum input (corresponding to maximum aerial current) is shown on the transmitter milliammeter. The tuning point is well defined.

38. The setting of the artificial aerial for this particular frequency is noted and the procedure repeated for any other frequency required. The settings of the artificial aerial thus recorded may then be used for initial setting-up of a transmitter intended to be used on a similar aerial system, and at similar frequencies. Bench testing of the transmitter will be greatly facilitated by the use of the artificial aerial since the value of capacitance (matched to the aircraft for a particular frequency) is now known and may be used for this purpose.

CONSTRUCTIONAL DETAILS

Transmitter

39. Four views of the transmitter are given in figs. 1, 8, 9 and 11, and a bench wiring diagram in fig. 10. All the components of the transmitter with the exception of the send-receive switch are carried on a removable panel. The panel is carried in a case, the sides of which are perforated

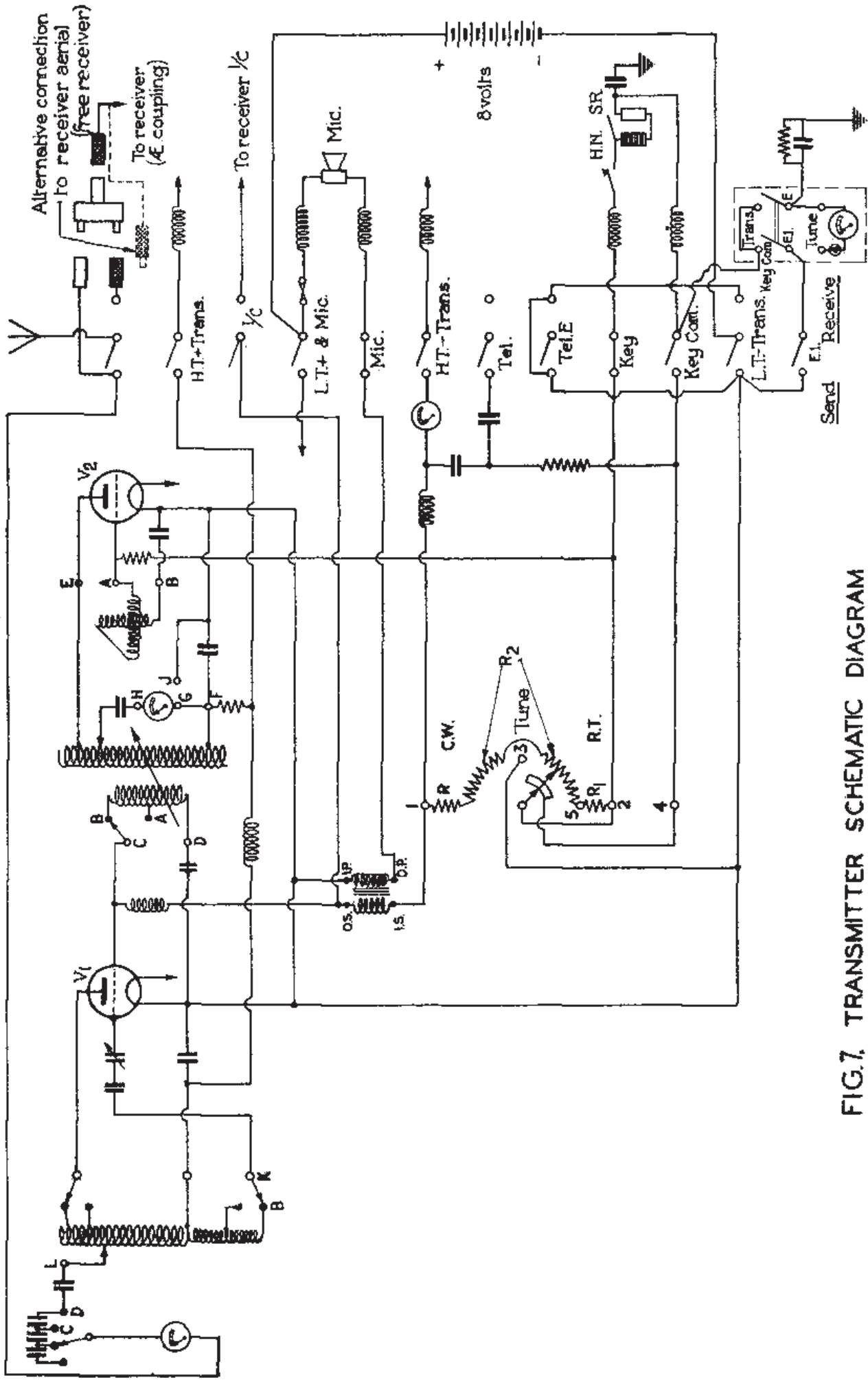


FIG. 7. TRANSMITTER SCHEMATIC DIAGRAM

for ventilation, and the transmitter may be lifted out of the case after loosening three screws in hinged clamps. The master-oscillator unit is screened by a metal case having a removable bottom. On the panel above the valves (6 and 7, fig. 1) are hinged perforated caps for protection. The weight of the transmitter alone, without coils, is 16 lb. 4 oz., and the approximate dimensions are $12\frac{1}{2}$ in. $\times$ $11\frac{1}{2}$ in. $\times$ 10 in.

40. Referring to fig. 1, the series aerial condenser switch (10) can be seen between the aerial ammeter (5) and the amplifier grid-bias switch (8). Next to this switch is a milliammeter (4) reading from 0 to 150 which is connected in the H.T. circuit through a choke and indicates the total input. The thermo-ammeter (3) on the top left-hand corner is in the anode circuit of the M/O valve. It reads from 0 to 3 amps and indicates the oscillatory current in the M/O circuit.

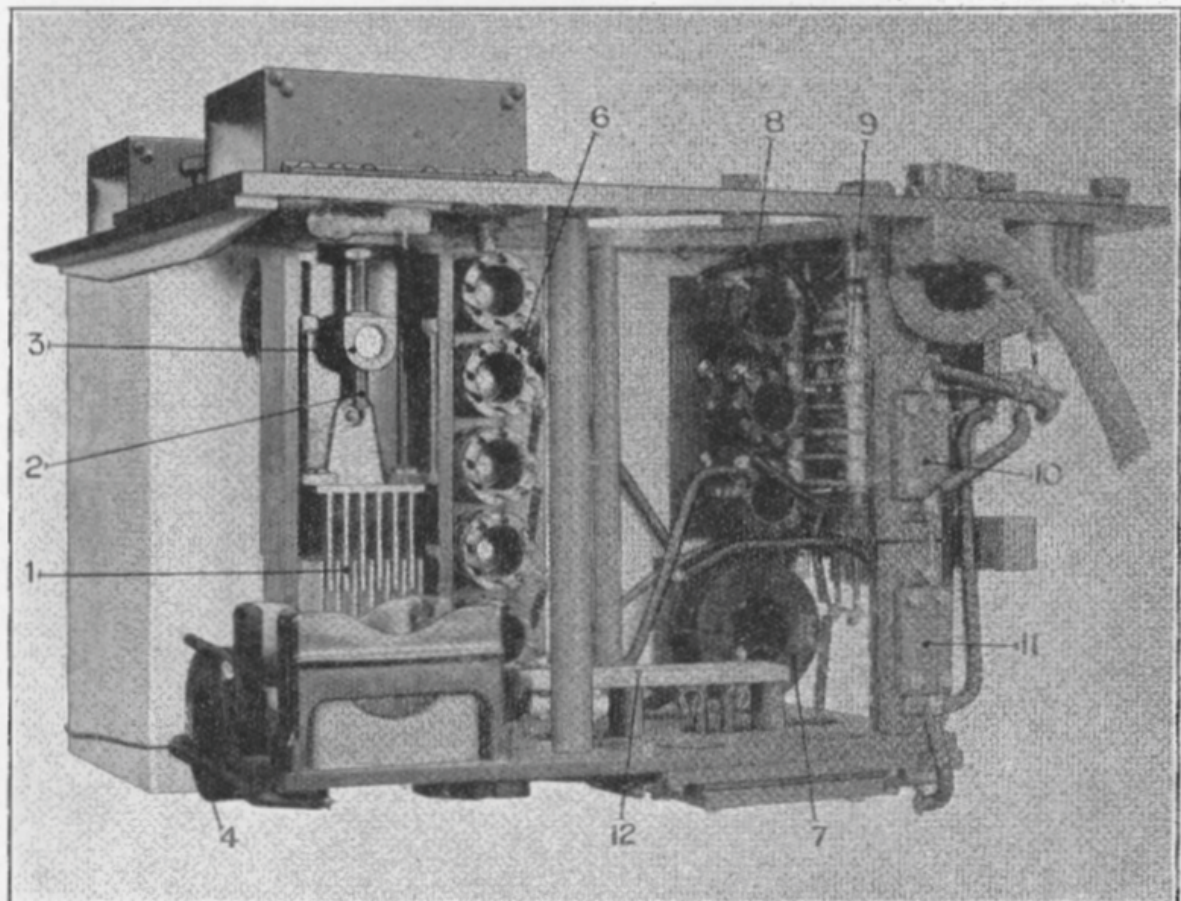


FIG. 8. Interior view of transmitter, amplifier components.

Below these two instruments can be seen the coil-holder (1) for the master-oscillator coil and to the right of it the coil-holder (2) for the amplifier coil. To the left of the amplifier valve (7) can be seen the handle (9) of the neutralizing condenser. The small knurled metal nut below this forms a locking device for the condenser. The amount of movement of the condenser is indicated on a scale which can be seen to the left of this unit.

41. Fig. 8 is an interior view of the transmitter, showing the components in the amplifier section, the valve having been removed. In the left foreground can be seen the amplifier valve-holder and behind this the neutralizing condenser (1). As can be seen, this is a variable air-dielectric condenser, the bottom set of plates being fixed and the upper set of plates being movable. Movement is obtained by the screw (2), secured to the handle (9, fig. 1), engaging the nut (3).

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To the left of this condenser can be seen a choke (4), one end of which is connected in the grid circuit of the amplifier valve, the other end of which is connected to the fixed plates of the neutralizing condenser. To the right of the neutralizing condenser can be seen a bank of five resistances (6), each of 2,000 ohms, connected in series. One end of the bank is connected to the choke (7) and the other end is connected to the terminal engraved F on the M/O coil socket (see fig. 2). The three resistances (8) seen above the choke (7) have a value of 6,600 ohms each

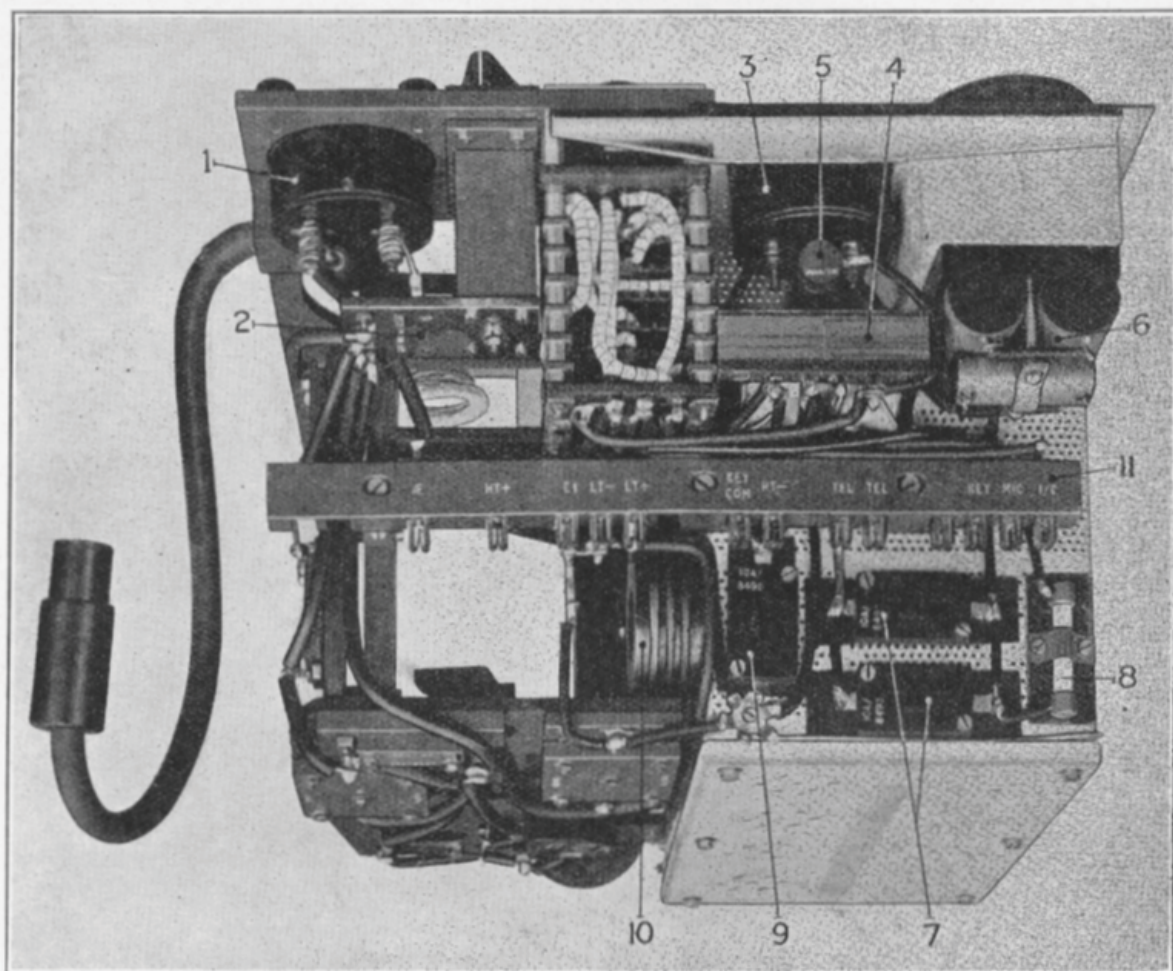
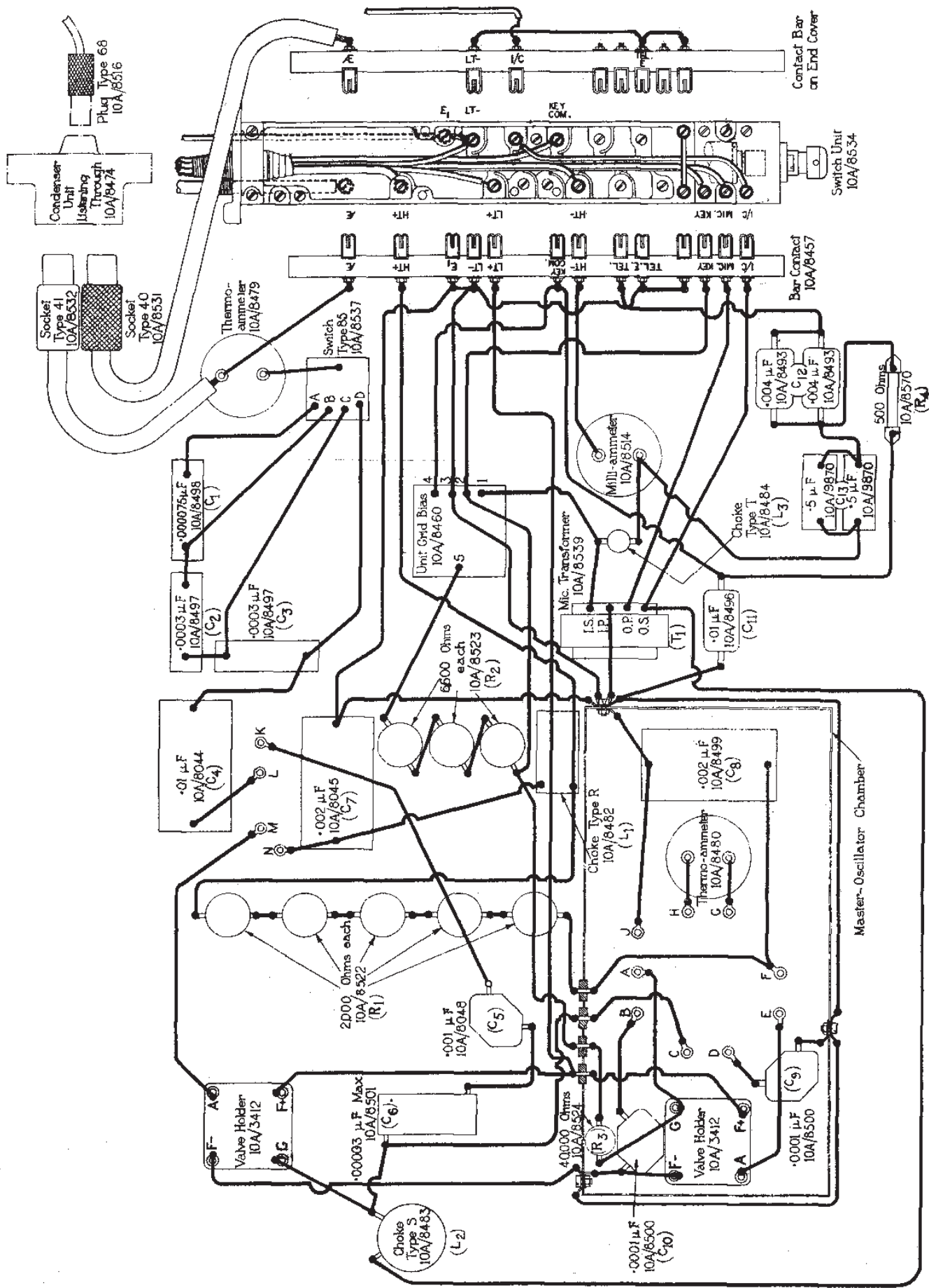


FIG. 9. Interior view of transmitter, M/O components.

and form with the resistance unit (9) the grid-bias resistance for the amplifier valve. In the right-hand foreground can be seen two condensers (10) and (11) having values of $0.000075\mu\text{F}$ and $0.0003\mu\text{F}$ respectively. These condensers are connected to the series aerial condenser switch (10, fig. 1). In the centre foreground can be seen the amplifier coil-holder (12), the sockets of which are engraved K, L, M and N. They are connected up as shown in the bench wiring diagram (fig. 10).

42. Fig. 9 is an interior view of the transmitter showing the aerial ammeter (1) in the top left-hand corner and beneath this the series aerial condenser switch (2). Adjacent to this switch on the right-hand side is the grid-bias resistance unit (9, fig. 8). To the right of this unit can be seen the input milliammeter (3) and below this the microphone transformer (4). The primary winding is earthed at one end and the other end is connected to the microphone. The secondary winding is connected at one end to the grid-bias resistance and at the other end,



NOTE: Annotations in parenthesis, for example (C 5), refer to the corresponding annotations in Fig. 2

Facing paras. 43-46.

through a choke, to the grid of the amplifier valve. Above the transformer (4) is a choke (5) connected between the H.T. circuit and the secondary winding of the transformer. To the right of the choke is a group of condensers (6). Although three condensers may be seen in the illustration, the bottom one is left disconnected, while the other two which have a value of $0.5\mu\text{F}$ each, are connected in parallel and are indicated as C_{13} in the theoretical circuit diagram fig. 2. The two condensers (7) seen on the bottom right-hand side of fig. 9, have values of $.004\mu\text{F}$ each and are connected in parallel, giving a value of $.008\mu\text{F}$. These two condensers are represented by C_{12} in fig. 2. To the right of these two condensers is a resistance (8) having a value of 500 ohms. It is connected on one side to the condensers (6) and (7) and on the other side to KEY COM. The condenser (9) has a value of $.01\mu\text{F}$ and is connected between KEY COM and earth. The choke (10) to the left of this condenser may also be seen in fig. 8 and has been referred to previously.

43. The contact bar (11) which can be seen across the centre of the illustration lies alongside the switch unit when the transmitter is placed in the case. The blades on the switch rotor make contact at the various points when the switch is in the send position. Starting from the left-hand side, the contact engraved AE. is connected to one side of the aerial ammeter. H.T. + is connected to one side of the choke, E. and L.T. — are connected by a strip of metal behind the contacts and are connected to the metal screen. The contact L.T. + is connected to the filaments of the valves. The contact KEY COM is connected to the top of the condenser (9), and H.T. — is connected to one side of the milliammeter (3). Of the two contacts engraved TEL, the left-hand one is connected to the condensers (7) and the other is connected, at the back of the bar, to the fourth contact from the right. The contact engraved KEY is connected to the grid-bias resistance unit. The contact engraved MIC is connected to the transformer primary and the contact engraved I/C is connected to the transformer secondary.

44. Fig. 11 is another interior view of the transmitter showing the components from the underside. The cover on the metal screen surrounding the M/O valve, which can be seen in the right-hand bottom corner of fig. 9, has been removed. The two condensers (1) and (2) seen in the top right-hand corner, are two of the series aerial condensers. The smaller one (2) on the right has a value of $.0003\mu\text{F}$, and the larger one a value of $.01\mu\text{F}$. The condenser (3) seen below these two aerial condensers has a value of $.002\mu\text{F}$ and is connected between the socket engraved N on the amplifier coil-holder, and earth. The $.001\mu\text{F}$ condenser (4) seen in the middle of the panel is connected on one side to the amplifier coil socket engraved K and on the other side, in series with the neutralizing condenser, to the grid of the amplifier valve. These condensers are represented by C_5 and C_6 respectively in the theoretical circuit diagram, fig. 2.

45. The group of components located in the lower half of the figure are associated with the M/O valve. In the centre of the group can be seen the underside of the M/O coil-holder with the various sockets engraved A, B, C, D, E, F and J. The $.002\mu\text{F}$ condenser (5) seen on the right is connected across the socket J and F, the socket J being bonded to the metal screen. The $.0001\mu\text{F}$ condenser (6) is connected between the socket D and the metal screen. In the bottom left-hand corner is the M/O valve-holder (7). The grid terminal is connected to the coil socket A, the anode terminal to the socket E, and, of the two filament terminals, the top left-hand one is earthed to the metal screen and the bottom right-hand one is connected to L.T. +. The $.0001\mu\text{F}$ condenser (8) above the valve-holder, is earthed to the screen on one side and connected to the coil socket B on the other side.

Case

46. Fig. 12 is a view of the transmitter case showing the send-receive switch (3) in the background. The contact bar (1) can be removed from the case along with the perforated side to which it is secured. The send-receive switch consists of a barrel (3) carrying blades, and rotation of the barrel engages the blades with the fixed contacts on the bar (1), or with the fixed contacts (11, fig. 9) on the transmitter when the latter is in position. The base (2) of the send-receive switch has a number of fixed contacts in which the blades engage. The contacts are connected

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by a group of leads, which can be seen on the right of the case, to various components outside the transmitter, for example, the H.T. and L.T. supply, key, microphone, etc. The blades on the switch rotor (3) make contact with the fixed contacts on the base and the contacts on the transmitter and case in the send and receive positions respectively and thus connect the external

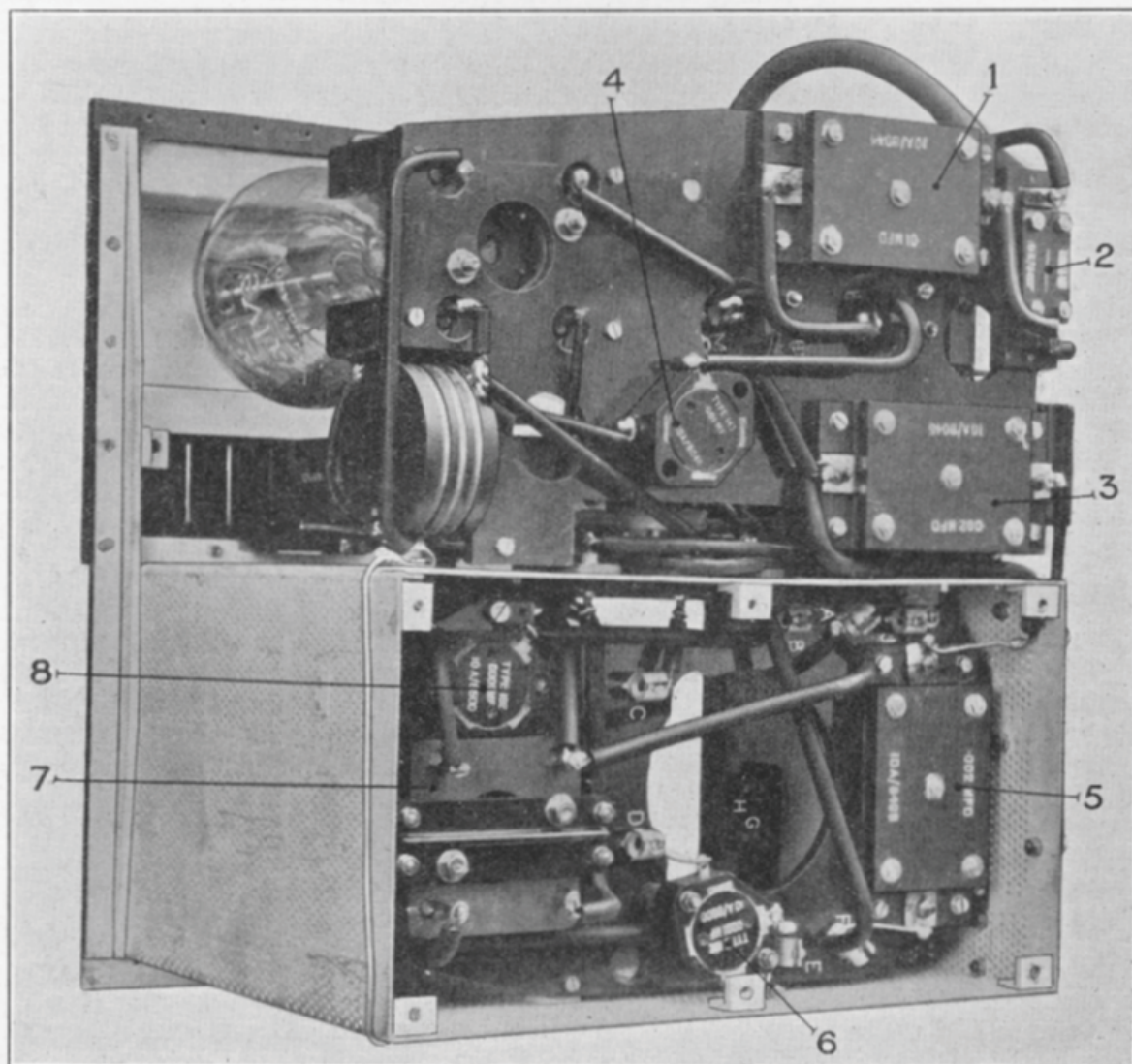


FIG. 11. Interior view of transmitter, underside.

apparatus in circuit as required. The case itself is a canvas covered wooden structure with perforated paxolin sides and bottom. The side carrying the receive contact bar can be removed by undoing four screws. It is necessary to remove this side before the switch unit (barrel (3) and base (2)) can be inserted. Dowel pins are provided at convenient points on the case to facilitate correct assembly and alignment.

47. The contact bar secured to the removable side of the case has eight contacts engraved (from the right) AE, L.T.—, I/C, L.T.+Rec, TEL, TEL/E, H.T.+ REC. The aerial plug-in lead (4) is connected to the contact AE, and another lead (5) terminating in a plug, type 86, is secured to the I/C contact. The contacts L.T.— and TEL/E are connected together inside the case. Another piece of wire connects the contact TEL/E to the last contact on the bar. This

contact engages a fixed blade contact on the base (2). The switch base (2) is provided with thirteen spring jaw contacts and six fixed blades. The two fixed blades on the right are not used in this transmitter. Six of the spring jaw contacts, reading from the right, are engraved AERIAL, H.T.+ TRANS, L.T.+ TRANS and MIC, H.T.— TRANS, TEL, H.T.+ REC. Of the fixed

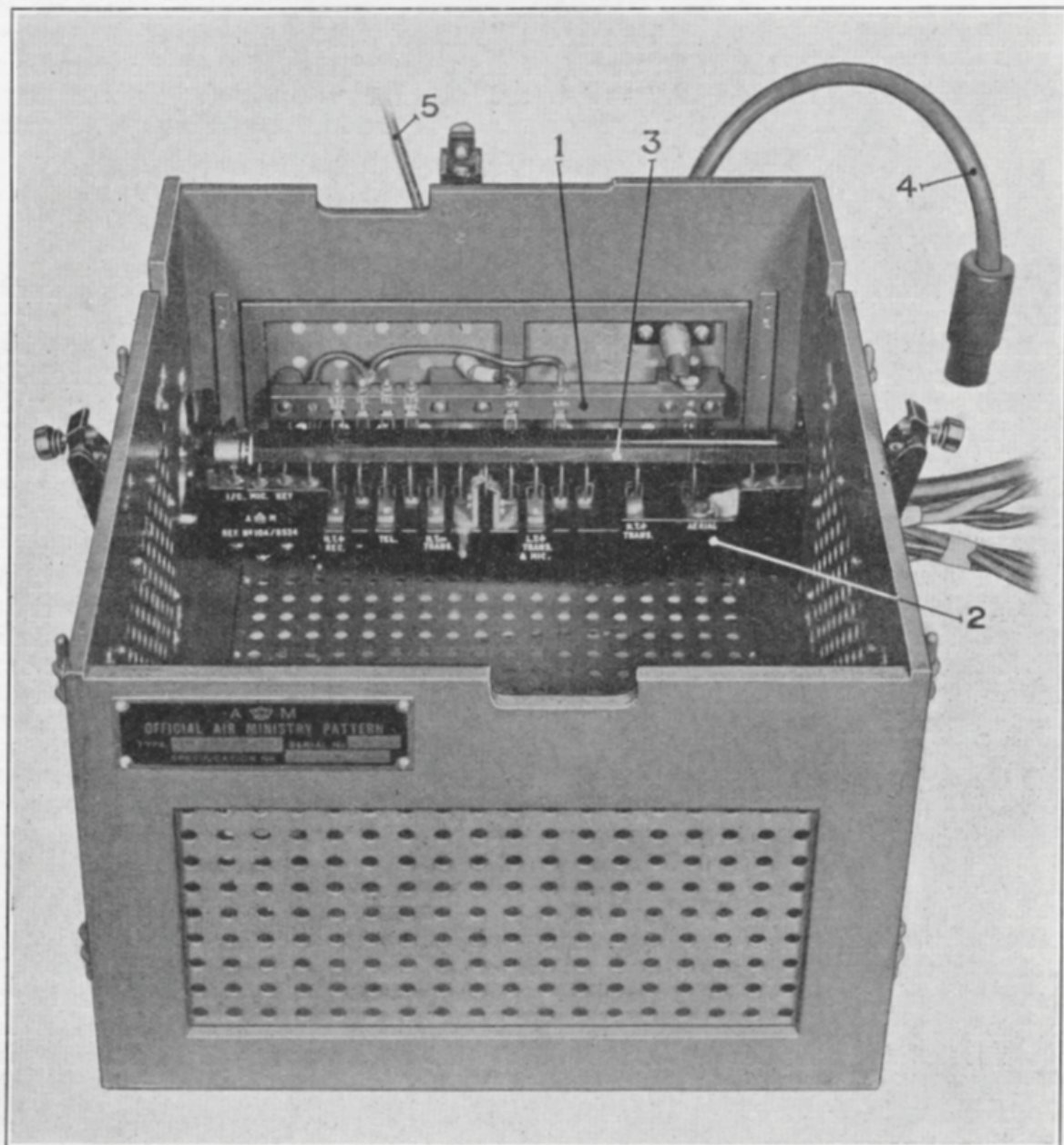


FIG. 12. Case and contact bar.

blades on the left, one is not engraved and is connected under the base to the corresponding blade contact on the receive side. The next three fixed blades are engraved, KEY, MIC, and I/C. These blades are always in engagement with the corresponding contacts on the transmitter contact bar (11, fig. 9) when the transmitter is in the case.

48. On the other side of the switch base (2) which may be seen by removing the side carrying the receive contact bar, the contacts are engraved (from the right) TEL E, L.T.+ REC,

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KEY COM, L.T.—TRANS, and E_1 ; also on the extreme right are four blade contacts, of which only the fourth one from the right is used. When the switch barrel (3) is in the receive position the blades make contact with the various contacts on the base as well as with the appropriate contacts on the bar (1). The barrel of the switch is provided with a coupling so that the switching over from send to receive and *vice versa* may be remote controlled. When the switch is in the intermediate position the circuits to the transmitter and receiver are broken as the blades are not engaged with either contact bar. The top left-hand corner of the front panel (fig. 1) is engraved S-OFF-R, and this engraving refers to the positions of the switch coupling. In the send position the blades on the barrel connect the external apparatus to the transmitter contact bar, and in the "R" position the blades connect the external apparatus to the "receive" contact bar (1).

Coils

49. The amplifier coil unit range A, consists of a former, built up from composite insulating material, carrying two coils and a top cover of synthetic-resin varnish-paper board. The connections from the coils are taken to plugs secured in the former base. A variable tap is provided on the inductance coil, which is controlled by a knob engraved in degrees (0° – 360°). An indicator device is also provided by means of which the number of complete turns made by the tap brush is registered. Two lifting knobs are also provided on the top cover. The base and top of the former are held together by three pillars of composite insulating material. The main inductance consists of a coil, formed of $\frac{1}{8}$ inch o/d, 22 s.w.g. silver-plated copper tube having $10\frac{1}{2}$ turns approximately. Two fixed anode taps are provided, one $3\frac{1}{2}$ turns and the other $4\frac{1}{2}$ turns from the top of the coil. Each anode tap is brought to a separate plug. The neutralizing winding is wound on the same former and in the same direction as the inductance coil and consists of $2\frac{1}{4}$ turns of 20 s.w.g. double cotton-covered copper wire. The finish of the neutralizing winding is connected to the start of the inductance coil and the junction brought to two plugs. Similarly the start of the neutralizing winding is also brought to two plugs in the base. From the disposition of the plugs it is possible to insert the coil unit in two different positions in the coil-holder. Two slots are provided on the top of the coil, one engraved 15,000 to 12,500 kc/s and the other engraved 13,000 to 10,000 kc/s, and when either slot is engaged with the projection (11, fig. 1) the anode tapping for that particular frequency band is engaged in the appropriate coil socket. The variable tap is brought to a central plug in the base of the coil. The various connections are shown in fig. 13.

50. The M/O coil unit range A consists of a tubular coil with a variable tap and two fixed taps, a tapped rotatable coupling coil, two fixed condensers and a choke all mounted within a framework consisting of a base plate of composite insulating material and a top plate of duralumin assembled together by four duralumin columns mounted one at each corner. The necessary operating knobs are mounted on the top plate. The control knob for the variable inductance is provided with an indicating device which registers each complete turn of the movable contact on the coil. In addition the knob is engraved in degrees from 0 to 360. A similar indicating device is provided for the coupling coil.

51. There are six pins or plugs secured to the base plate and engraved J, A, C, D, E, F, and two further plugs fixed in a bracket secured to the top plate and engraved H, and G. The variable inductance consists of a helical coil of 14 turns of $\frac{1}{8}$ inch o/d silver-plated 22 s.w.g. copper tube. Two fixed taps are provided, one at 3 turns from the bottom and one at 9 turns from the bottom, the former is connected to the plug F and the latter to the plug E. The movable contact is connected to one side of a $\cdot 00003\mu\text{F}$ fixed air dielectric condenser, the other side of the condenser being connected to the plug G. The bottom turn of the variable inductance is connected through a $\cdot 00007\mu\text{F}$ condenser and choke to the plug A. The plug J is connected to one of the duralumin columns. The plug H is connected to the start of the inductance.

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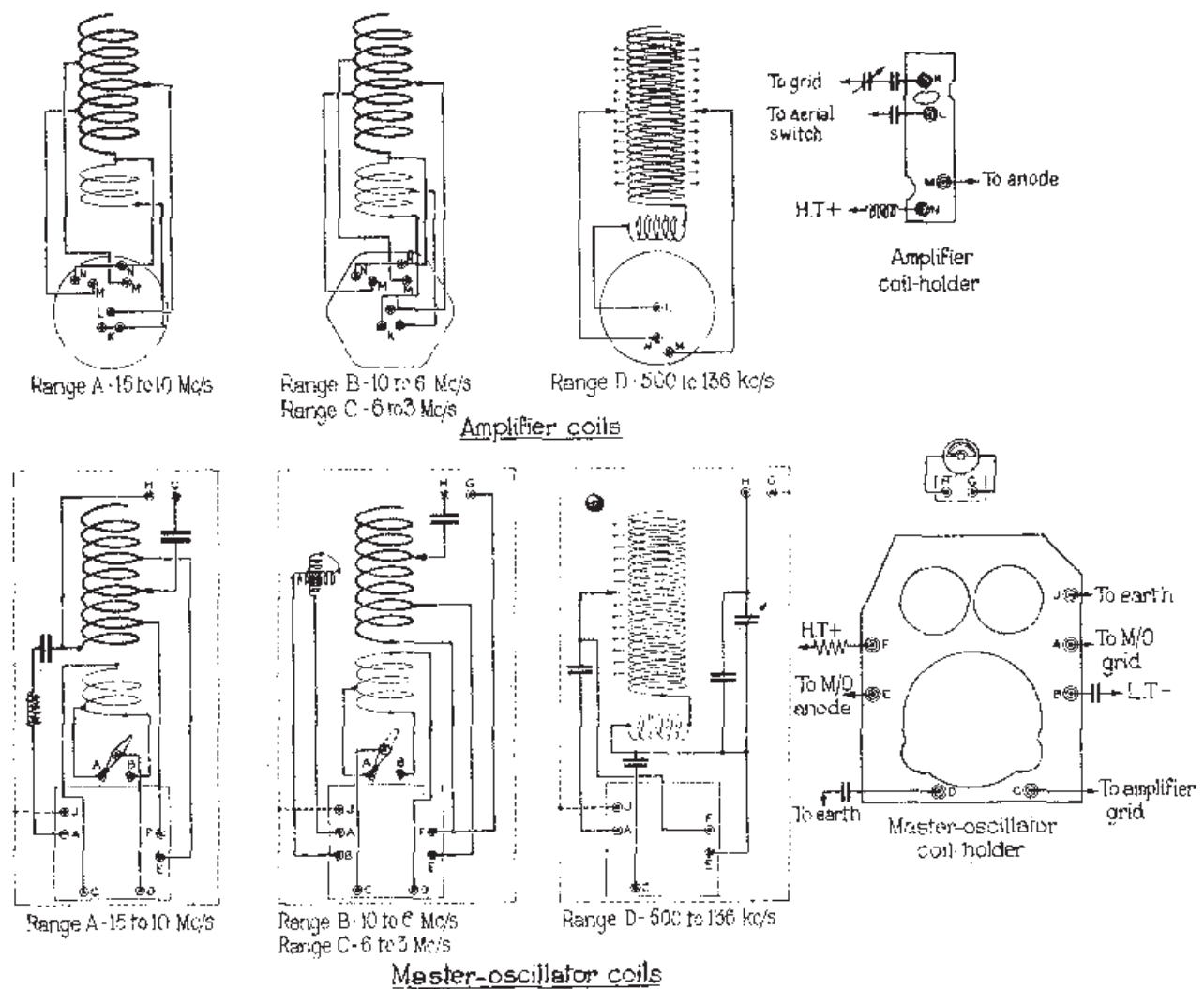


FIG.13, M/O AND AMPLIFIER COILS, CIRCUIT DIAGRAM

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52. The coupling coil is wound on a former of composite insulating material and is constructed so as to be variable with respect to the inductance coil. It is wound with $4\frac{3}{4}$ turns of 26 s.w.g. double cotton-covered copper wire and tapped at $3\frac{1}{2}$ turns. The start of the coil is connected to the plug C by a flexible copper connection, while the plug D is connected to a movable arm on the coil former. This arm can be set to one of two positions engraved A and B. The finish of the winding is connected to B and the tap to A.

53. The amplifier coil unit range B (10,000 to 6,000 kc/s) consists of a former, built up from composite insulating material carrying two coils, enclosed in a perforated tube. A top cover of synthetic-resin varnish-paper board carries a control knob engraved in degrees from 0 to 360 and an indicating device. The knob controls the movable contact on the variable inductance, and the indicating device registers the number of complete turns made by the brush on the coil. The top cover is provided with two slots engraved 4,400 to 3,000 kc/s and 6,000 to 4,300 kc/s. One or the other of these two slots register with the projection (11, fig. 1), when the coil is in position, thus giving two positions in which the coil may be plugged into its socket. A suitable number of pins are provided on the coil base for this purpose, only four of the seven pins being in use for each frequency band.

54. The inductance coil consists of a helix of silver-plated 22 s.w.g. copper tubing of $\frac{1}{8}$ inch o/d having 19 turns. Two fixed taps are taken off the coil, one at $8\frac{1}{2}$ turns from the top of the coil, and one at $9\frac{1}{2}$ turns from the top of the coil, each tap being connected to a separate pin in the base. The neutralizing winding is wound with $3\frac{1}{2}$ turns of 20 s.w.g. double cotton-covered copper wire in the same direction as the main coil and a tapping is taken off at one turn and connected to one of the pins, the start of the neutralizing winding being connected to an adjacent pin. Thus $3\frac{1}{2}$ or $2\frac{1}{2}$ turns of the neutralizing winding may be used, depending on which way the coil is inserted in its socket. The movable contact is connected to a central pin which is common to both positions of the coil. The end of the neutralizing winding is connected to the start of the main winding and the junction taken to two separate pins so that one or the other will be in use, depending on the position of the coil in its socket.

55. The M/O coil unit range B (10,000 to 6,000 kc/s) consists of a tubular coil with a variable tap, a tapped coupling coil, a variometer and a fixed condenser mounted within a framework consisting of a base plate of composite insulating material and a top plate of duralumin assembled together by four duralumin columns mounted one at each corner. The necessary operating knobs fitted with locking devices are mounted on the top plate. The variable inductance has an indicating device showing the number of turns made by the movable tap and a scale engraved in degrees from 0 to 360. The grid variometer scale is engraved from 0° to 180° and the coupling coil control has a scale engraved from 0 to 9. Two lifting knobs are also provided on the top plate. The base of the coil is provided with seven pins, engraved J, A, B, C, D, E and F. Two further pins are mounted in a bracket secured to the underside of the top plate and engraved G and H.

56. The variable inductance consists of a helical coil wound with 18 turns of $\frac{1}{8}$ inch o/d silver-plated 22 s.w.g. copper tube, tapped at the seventh turn from the top of the coil. This tap is connected to the pin engraved E. The start of the coil is connected to the pin F and another connection is made from here to the pin G. The movable tap of the coil is connected to one side of a .000065 μ F fixed air dielectric condenser, the other side of the condenser being connected to the pin H. The grid variometer is connected between the pins A and B. The stator and rotor are each wound in two parts on ebonite formers. The stator has $11\frac{3}{4}$ turns ($5\frac{3}{4}$ turns on each part) of 24 s.w.g. double cotton-covered copper wire, wound in a clockwise direction. The rotor has 13 turns ($6\frac{1}{4}$ and $6\frac{3}{4}$ turns) of 24 s.w.g. double cotton-covered wire wound in a clockwise direction. The coupling coil, which is wound on a movable former of composite insulating material, consists of a winding of $7\frac{7}{8}$ turns of 26 s.w.g. double cotton-covered copper wire, tapped at $4\frac{1}{2}$ turns from the start and wound in the same direction as the main coil. The finish of the coil is brought to a contact engraved B on the coil former and the tap is

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brought to a contact engraved A. A movable arm on the former can be placed on either contact, thus all, or a part of the coupling coil, can be used as desired. The start of the coil is connected to the pin D and the tapping arm is connected to the pin C.

57. The amplifier coil unit range C (6,000 to 3,000 kc/s) is similar to the coil unit range B as regards construction and internal connections. The two slots in the top cover are engraved 6,000 to 4,300 kc/s and 4,400 to 3,000 kc/s. The main inductance is wound with $22\frac{1}{2}$ turns of 22 s.w.g. silver-plated copper tubes, $\frac{1}{8}$ inch o/d. One tap is taken at $6\frac{1}{2}$ turns from the top of the coil and another tap is taken at $10\frac{1}{2}$ turns from the top of the coil. The neutralizing winding is wound with $8\frac{1}{2}$ turns of 22 s.w.g. double cotton-covered copper wire in the same direction as the main coil and tapped at 2 turns from the start. The disposition of the pins and the way in which they are connected to the various windings can be seen in fig. 13.

58. The M/O coil unit range C (6,000 to 3,000 kc/s) is constructed in a similar manner to the coil unit range B, the connections also being similar. The main inductance is wound with 24 turns of $\frac{1}{8}$ inch o/d silver-plated 22 s.w.g. copper tube, tapped at the sixth turn from the top of the coil. The coupling winding is wound in the same direction as the main coil and consists of $14\frac{5}{7}$ turns of 34 s.w.g. double cotton-covered copper wire, tapped at $8\frac{1}{3}$ turns from the start. The grid variometer and fixed condenser are of similar construction to those fitted in the range B unit, but are of different values. The condenser is a .000115 μ F fixed air-dielectric condenser, the variometer rotor is wound with 26 turns ($13\frac{1}{2}$ and $12\frac{1}{2}$ turns) of 28 s.w.g. double cotton-covered copper wire, and the stator is wound with $22\frac{3}{4}$ turns ($10\frac{7}{8}$ and $11\frac{7}{8}$ turns) of 28 s.w.g. double cotton-covered copper wire. All the windings on the grid variometer are in a clockwise direction from the start. The disposition of the pins and the connections to the various windings are illustrated in fig. 13.

59. The amplifier coil unit range D (500 to 136 kc/s) comprises a variable inductance consisting of rotor and stator, having 28 tapping points brought out to 14 pairs of contacts on a coarse tuning switch, the coil and switch being mounted between end plates of synthetic-resin varnish-paper board and enclosed within a perforated tube and cover of the same material. The operating knobs project through the top cover and are each provided with a device to indicate the positions of the switch and rotor respectively. Both stator and rotor are wound with 27/40 Litz wire. Each strand is single silk-covered and the 27 strands are covered overall with a double silk covering. There are 14 aerial and 14 anode taps taken from the stator, which is wound counter-clockwise looking at the coil from the rotor end, each section having 9 turns. The 14 aerial tapings 1, 2, 3, etc., are taken at the following sections, 6, 8, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 51 and 55, the 14 anode taps 1, 2, 3, etc., are taken at the sections 1, 3, 4, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35 and 38 respectively. The coarse tuning switch controls both the aerial and anode taps. The fine tuning is accomplished with the rotor, which is wound in halves, each half comprising five sections of eight turns per section. Three pins are secured to the base of the coil engraved L, M, and N. The pin L is connected to the start of the rotor winding, the pin M is connected to the movable anode tap, and the pin N is connected to the movable aerial tap. The finish of the rotor winding and the start of the stator winding are joined together inside the coil.

60. The M/O coil unit range D (500 to 236 kc/s) consists of a variable inductance comprising a rotor and a stator having 14 tapping points brought out to the contacts of a coarse tuning switch, three fixed condensers and one adjustable condenser mounted on a panel. All these components are mounted within a framework consisting of a base and top plate of synthetic-resin varnish paper board assembled together by four supports of duralumin mounted one at each corner. The top of the unit is enclosed by a cover of duralumin through which the knobs operating the switch and rotor project. The knobs are each provided with a device to indicate the positions of the switch and rotor respectively. The rotor is wound in halves having 5 sections each and 8 turns per section of 27/42 Litz wire. The stator is wound in sections, each

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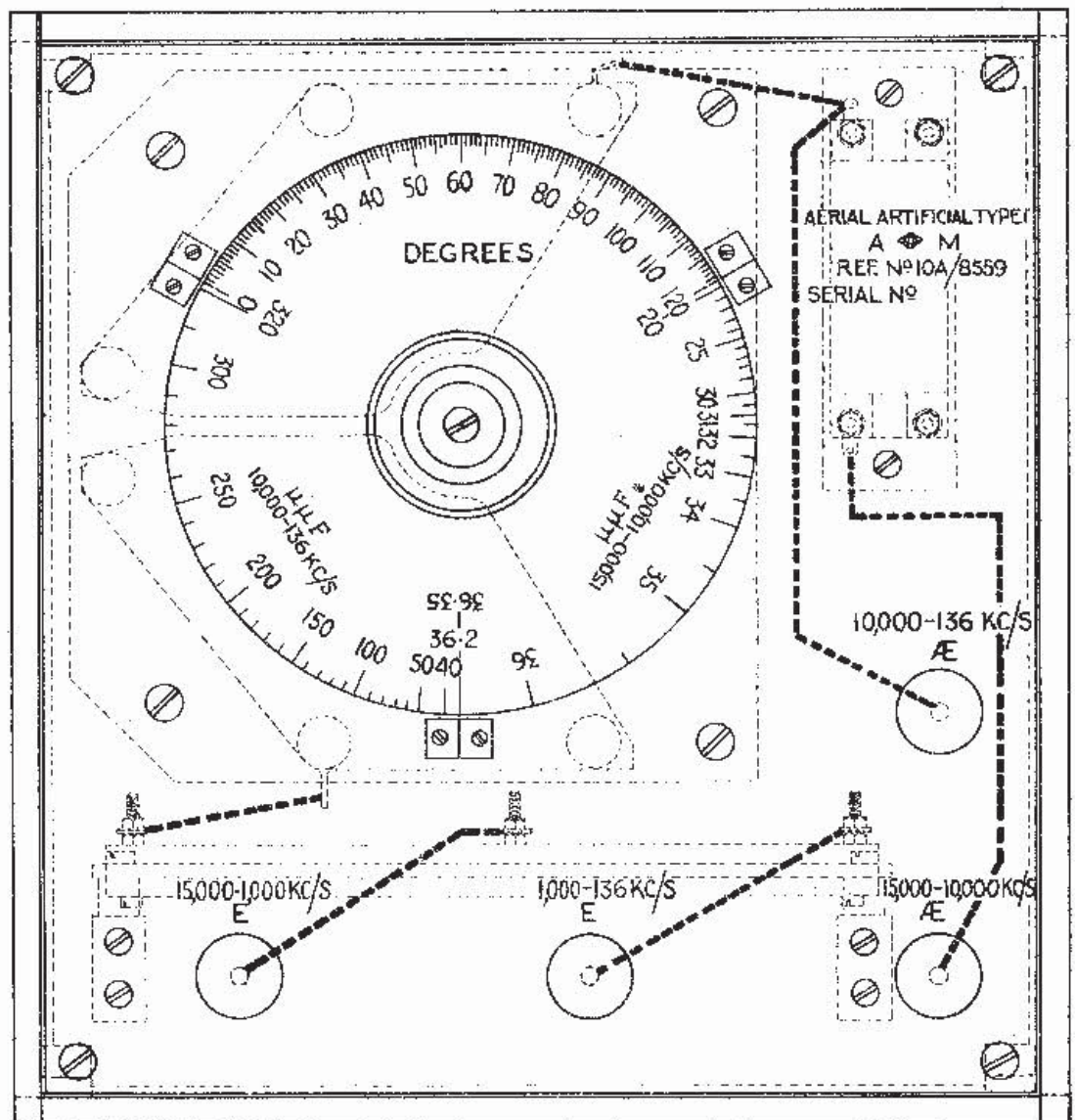
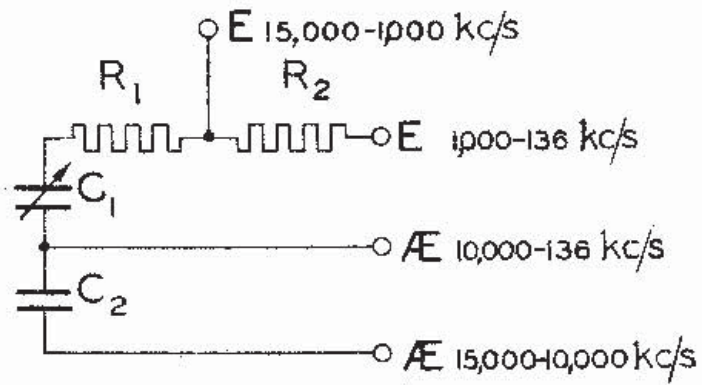


FIG.14, ARTIFICIAL AERIAL TYPE I

section having 9 turns of 27/40 Litz wire. There are 14 taps provided in the following order from the bottom of the coil : sections 6, 8, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 51 and 55. The start of the stator winding is connected to the end of the rotor winding.

61. The base of the coil is provided with five pins engraved J, A, C, E, F ; two further pins carried in a bracket on the condenser panel are engraved H and G. The pin J is connected to one of the duralumin columns and the pin G is also connected to one of these columns. The pin E is connected through a $\cdot 000038\mu F$ condenser to the pin C. The pin F is connected through a $\cdot 001\mu F$ condenser to the pin A. The pin H is connected through an adjustable condenser $\cdot 00002\mu F$ max. to the pin E in parallel with a $\cdot 00026\mu F$ condenser. The finish of the rotor winding is also connected to the pin E. The disposition of the pins and the various connections can be seen in fig. 13.

Artificial aerial

62. The artificial aerial, an illustration of which is given in fig. 14, comprises a variable condenser, a fixed condenser and a tapped resistance, all mounted on a panel with the necessary aerial and earth terminals, and fitted into a wooden case. As can be seen from the diagram, two aerial and two earth connections are employed. When it is required to employ the instrument on frequencies above 1,000 kc/s, the earth terminal marked 15,000–1,000 kc/s is used, and the resistance R_1 (8 ohms) only is in circuit with the capacitance. For the frequencies below 1,000 kc/s the earth terminal marked 1,000–136 kc/s is used, and the resistance R_2 (7 ohms) is added in series. In a similar way the series capacitance is altered for the different frequency bands by selecting the appropriate aerial terminal. For frequencies below 10,000 kc/s the aerial terminal marked 10,000–136 kc/s is used, and the variable condenser C_1 ($\cdot 0003\mu F$) only is in circuit with the resistance. For frequencies above 10,000 kc/s the aerial terminal marked 15,000–10,000 kc/s is used, and the fixed condenser C_2 ($\cdot 00003\mu F$) is connected in series.

63. The dial of the condenser is provided with a scale engraved from 0–120 degrees. In addition, two other scales are engraved on the dial giving values of capacitance in micro-microfarads. One of these is used for settings on the 15,000–10,000 kc/s range and the other is used on the 10,000–136 kc/s range. The actual calibrations of capacitance are made with the 15,000–1,000 kc/s earth terminal and 15,000–10,000 aerial terminal in use for the former scale and with the 1,000–136 kc/s earth terminal and 10,000–136 kc/s aerial terminal in use for the latter scale. Three indicator blocks, each of which is engraved with a datum line, are carried on the panel, equidistant around the periphery of the dial. Each scale is set or read against the appropriate datum line.

64. As will be seen from the circuit diagram in the upper part of fig. 14 the effect of connecting up the instrument is to place across the aerial and earth terminals of the transmitter a capacitance and resistance in series. The values used are a compromise of those actually required for the various aerial systems used on aircraft and consequently when the aircraft aerial system is again connected to the transmitter, re-tuning of the aerial circuit of the latter will in general be necessary. Where master-oscillator transmitters are used, it will generally be found that re-tuning of the master-oscillator stage is not necessary although it is still necessary for the aerial circuit.

65. The lengths of the leads between the transmitter and artificial aerial should be as short as possible, especially on the higher frequencies and should be spaced well apart. Further, the type of wire used for the leads should be similar to that normally used between the transmitter and aerial reel, i.e. cable, electric, uniplug 12, red braided (Stores Ref. 5A:917).

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TABLE 1
(Key to installation diagram, fig. 15)

Item No.	Stores Ref.	Nomenclature.	Quantity.	Remarks.
1	10A/8415	Receiver R 1082		Without valves, coils or lamps. Complete with plugs, leads and sockets.
2	5A/1333	Battery, dry, 120 volts, type A	1	
3	10A/488	Plug, type 1, telephone	1	
4	10A/8516	Plug, type 68	1	
5	10A/3387	Terminal, 2 B.A., type A	1	
6	10A/8456	Transmitter T.1083	1	Without valves and coils. Complete with plugs, sockets and leads.
7	10A/9871	Switch unit, type D, wired for Battle aeroplane.	1	Complete with plugs, sockets, leads and choke unit (10A/8464).
8	10A/8580	Adaptor, ring, switch coupling	1	
9	10A/7741	Key, Morse, type F	1	
10	10A/8533	Socket, type 42, 4-point, H.T. type ..	1	
11	10A/8551	Disc, indicating, type D	1	For 10A/8533.
12	5A/81	Cable, H.T., uniplug, unbraided		As required.
13	5A/916	Cable, L.T., unsheath 4, red unbraided		As required.
14	10A/8525	Smoothing unit, H.F., type A	1	
15	5A/91	Cable, L.T., duflex 19, yellow braided ..		As required.
16	10A/7997	Starter, type A	1	For T.1083.
17	10A/8118	Plug, type 62, 2-point	1	
18	10A/8051	Disc, indicating, type E	1	For 10A/8118.
19	10A/7437	Socket, type 19, 2-point	1	
20	10A/8120	Disc, indicating, type F	1	For 10A/7437.
21	N.I.V.	Socket, jacelite, 3-pin, 5 amp.	1	Cat. No. 7170.
22	N.I.V.	Plug, jacelite, 3-pin, 5 amp.	1	Cat. No. 7110.
23	10A/3387	Terminal, 2 B.A., type A, spring type ..	1	Bonded to longeron.
24	5A/1387	Accumulator, 2-V, 20Ah., type B	1	For R 1082.
25	10A/3387	Terminal, 2 B.A., type A, spring type ..	1	
26	10A/7532	Generator-motor, 80-watt, type C	1	
27	N.I.V.	Crate, power supply	1	
28	5A/1387	Accumulator, 2-V, 20-Ah., type B	4	For T.1083.
29	N.I.V.	Crate, accumulator	1	For 5A/1387.
30	10A/8475	Neutralizing unit	1	
31	5A/1385	Lamp, filament, 4-V, 1-2 watts	1	For 10A/8475.
32	10A/8473	Condenser unit, earth	1	
33	10A/3387	Terminal, 2 B.A., type A	2	Bonded to panel.
34	10A/8474	Condenser unit, listening-through	1	
35	10A/9000	Plug, type 72, S.P. unispark cable	2	
36	10A/7437	Socket, type 19, 2-point	1	
37	10A/7962	Disc, indicating type D	1	For 10A/7437.
38	5A/919	Cable, L.T., uniflex 4, red-braided		As required.
39	5C/430	Block terminal, type B, two-way, No. 1	6	
40	10A/7971	Socket, type 29, Tel-Mic, parallel type ..	3	
41	10A/9005	Aerial winch, type 5 (frame)	1	For trailing aerial.
42	10A/9123	Aerial winch reel, type B	1	For aerial trailing.
43	10A/8531	Socket, type 40, S.P. unispark cable	1	Trailing aerial to R.1082.
44	10A/8531	Socket, type 40	1	For aerial winch.
45	N.I.V.	Aerial fairlead clamp	1	
46	10A/7986	Aerial fairlead bush, insulating	1	
47	N.I.V.	Aerial fairlead bush, steady	1	
48	10A/216	Aerial fairlead, tube, Duxine, 1 in.	1	
49	10A/8913	Aerial fairlead bush, steel 1 in., type 3, flared.	1	
50	10A/8235	Aerial wire, stainless steel		As required.
51	10A/7298	Aerial weight, bead type, No. 1		As required.
52	5A/82	Cable, H.T., unispark 7, unbraided		As required.
53	10A/8093	Aerial insulator, type 16, lead-in	1	For fixed aerial.
54	10A/4589	Aerial wire R.4		As required.

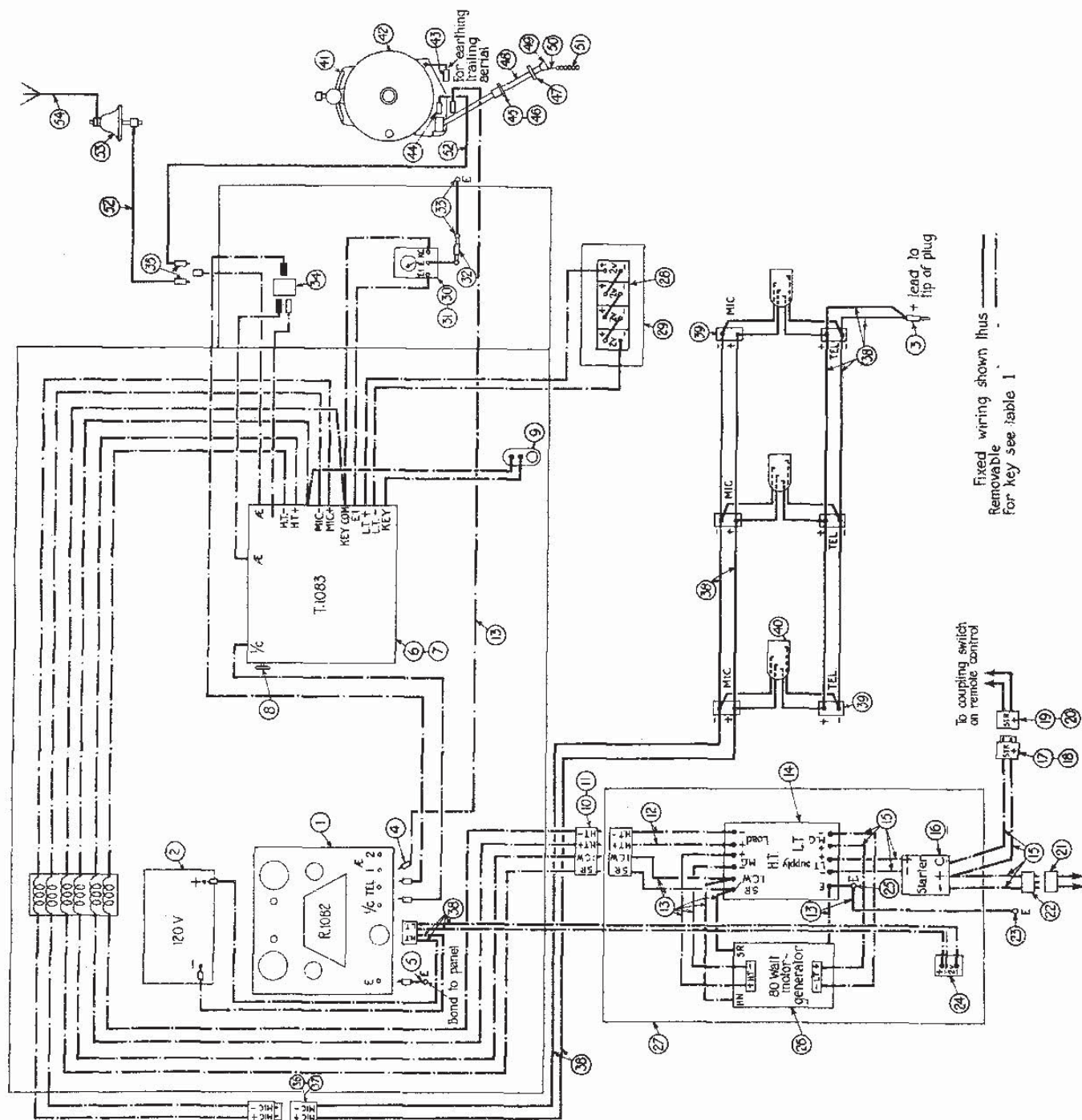


FIG. 15. INSTALLATION DIAGRAM (WITHOUT 1/C)

VALVES, BATTERY AND H.T. SUPPLY

66. The transmitter employs two type V.T.25 valves (8 volts, 2.2 amps). One valve is used as an oscillator and one as an amplifier. The H.T. supply is obtained from an 80-watt motor-generator, type C, driven by the 12-volt aeroplane supply, while the L.T. is obtained from four 2-volt accumulators 5A/1387 stored in the same crate as the receiver L.T. and H.T. supply.

INSTALLATION

67. Figs. 15 and 16 are typical installation diagrams for transmitter T.1083 and receiver R.1082. It will be seen that a plug and socket connection enables either a fixed or trailing aerial to be selected. The H.T. supply to the transmitter is obtained from an 80-watt motor-generator. The L.T. supply for the filaments is obtained from four 2-volt accumulators. A plug and socket connection is provided between the transmitter and the accumulators.

68. When a motor-generator, type B or C, is used a smoothing unit is necessary for listening-through. This smoothing unit (Stores Ref. 10A/8525) consists of a system of chokes and condensers connected in the L.T. and H.T. circuits, of the motor-generator. The unit has two terminal blocks. One is engraved E : L.T. supply, + and - ; and M.G. + and - ; and another is engraved S.R. ; I.C.W. ; M.G. - and + ; and Load, + and -. On the L.T. side the terminal engraved E is connected to a suitable earth. A choke is connected internally between the terminals marked supply + and M.G. +, and another choke is connected between the terminals marked supply - and M.G. -. Two condensers, with their junction-point earthed, are connected in series across the terminals marked M.G. + and -. On the H.T. side of the smoothing unit, a choke is connected between the terminals marked Load - and M.G. -, and another choke is connected between the terminals marked M.G. + and Load +. Two condensers in series have their junction-point earthed and are connected between the terminals marked M.G. + and -. The terminal marked S.R. is connected externally to the S.R. terminal on the motor-generator, and the terminal I.C.W. is connected to the terminal H.N. on the motor-generator. A small $0.01\mu\text{F}$ condenser inside the smoothing unit is connected between the terminal marked S.R. and earth. A switch is provided to short-circuit the terminals S.R. and I.C.W. If it is desired to change from I.C.W. to C.W. at a remote position, a pair of leads is taken from these two terminals to a tumbler switch (Stores Ref. 5C/621), and in this case the switch on the unit is locked in the off position. The L.T. to the smoothing unit and hence to the motor-generator is obtained from the aeroplane 12-volt supply. Two leads are brought to an automatic starter, type A (Stores Ref. 10A/7997), which is wired up in series with the switch, type 89, on the remote controls (see fig. 6). From the starter two leads are taken to the L.T. side of the smoothing unit and from there to the L.T. or motor side of the motor-generator. An alternative starting arrangement is sometimes employed. The 12-volt supply is taken to a switch, type 49, which is manually operated and has three positions: "start," "run," "off". In the "start" position a resistance is included in the armature circuit and in the "run" position it is cut out. It should be noted that motor-generators, types A, B and C, should receive their L.T. supply from the 12-volt battery and not from the "lighting load" connections (see A.P. 1095/G.12). If a motor-generator, type E, is used the L.T. supply is taken from the "lighting load" circuit. The smoothing unit (Stores Ref. 10A/8525) will probably be dispensed with when type E motor-generators are brought into service.

69. There are fourteen connections from the transmitter, six of which, namely, the H.T. supply, the microphone and key, are taken through a choke unit (Stores Ref. 10A/8464). Of the other eight, one is the I/C connection which is taken to the receiver, and two other connections terminate in sockets and are taken to the listening-through unit. The earth connection is taken through a neutralizing unit (Stores Ref. 10A/8473) external to the transmitter. This unit comprises a sensitive thermo-ammeter in series with a pea-lamp and a D.P.D.T. switch. The pea-lamp serves both as a visual indicator and as a fuse. In one position the switch connects

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the filament circuit directly to the earth condenser unit, and in the other position it connects the filament circuit to earth through the pea-lamp and ammeter in series. The aerial lead to the transmitter terminates at a plug and socket connection which enables either the fixed aerial or the trailing aerial to be used. The remaining two connections are the L.T. leads to the accumulators.

70. An examination of the connections to the listening through unit will show that, in addition to the two connections from the transmitter, another plug-in connection is taken to the aerial socket on the receiver. This connection of the listening-through unit ensures that the receiver is always connected to the transmitter inductance through a small condenser. The receiver being connected up through a condenser whilst the transmitter is actually in operation, the operator is enabled to listen between pauses in transmission without having to operate the change-over switch. To obtain "free receiver" (independent connection of the receiver to the aerial) sockets, type 41 and 40 (see fig. 15 or 16), should be removed from the listening-through unit and plug, type 68, should be mated with socket, type 40.

71. The I/C connection between the transmitter and receiver enables the audio-frequency amplifying portion of the receiver to be utilized for telephonic communication between the occupants of the aeroplane. This is accomplished by providing a 4-point jack at each position in the aircraft, one pair of contacts of each jack being wired in parallel to a telephone plug engaging with a socket on the receiver. The 4-way cord connected to the telephone and microphone worn by each occupant terminates in a 4-way plug. When this plug is inserted into the above-mentioned jack, the microphones are connected to the microphone transformer in the transmitter and the telephones are connected in the output circuit of the receiver. Thus, during transmission any one of the occupants, by speaking into his microphone, may transmit R/T, and during reception he may speak through the receiver to the other occupants.

72. Remote control may be provided on the send-receive switch and also on the tuning of the receiver. Incorporated in the send-receive remote control is a switch which gives remote operation on the motor-generator, starting the motor-generator when in the send position and stopping the motor-generator in the receive and "off" positions.

TABLE 2
(Key to Installation Diagram, fig. 16)

Item No.	Ref. No.	Nomenclature.	Quantity.	Remarks.
1	10A/8415	Receiver, type R.1082	1	Without valves, coils or dial lamps
2	N.I.V.	Crate receiver	1	Complete with plugs, lead and sockets.
3	10A/3387	Terminal, 2 B.A., type A, spring type ..	1	For receiver, earth.
4	10A/8516	Plug, type 68 (S.P.)	1	
5	5A/1333	Battery, dry, 120-V. type A	1	For R.1082
6	10A/7437	Socket, type 19 (2-point)	1	
7	10A/8602	Disc indicating, type H	1	For 10A/7437.
8	5A/1387	Accumulator, 2-V, 20-A.H., type A ..	5	One for R.1082, four for T.1083. Type B for tropical use.
9	N.I.V.	Crate battery	1	
10	10A/7437	Socket, type 19 (2-point)	1	
11	10A/8603	Disc indicating, type J	1	For 10A/7437.
12	10A/8456	Transmitter, type T.1083	1	Without valves and coils, complete with plugs, sockets and leads.
13	10A/9871	Switch unit, type D, wired for Wellington aeroplane.	1	Complete with plugs, sockets, leads and choke unit.

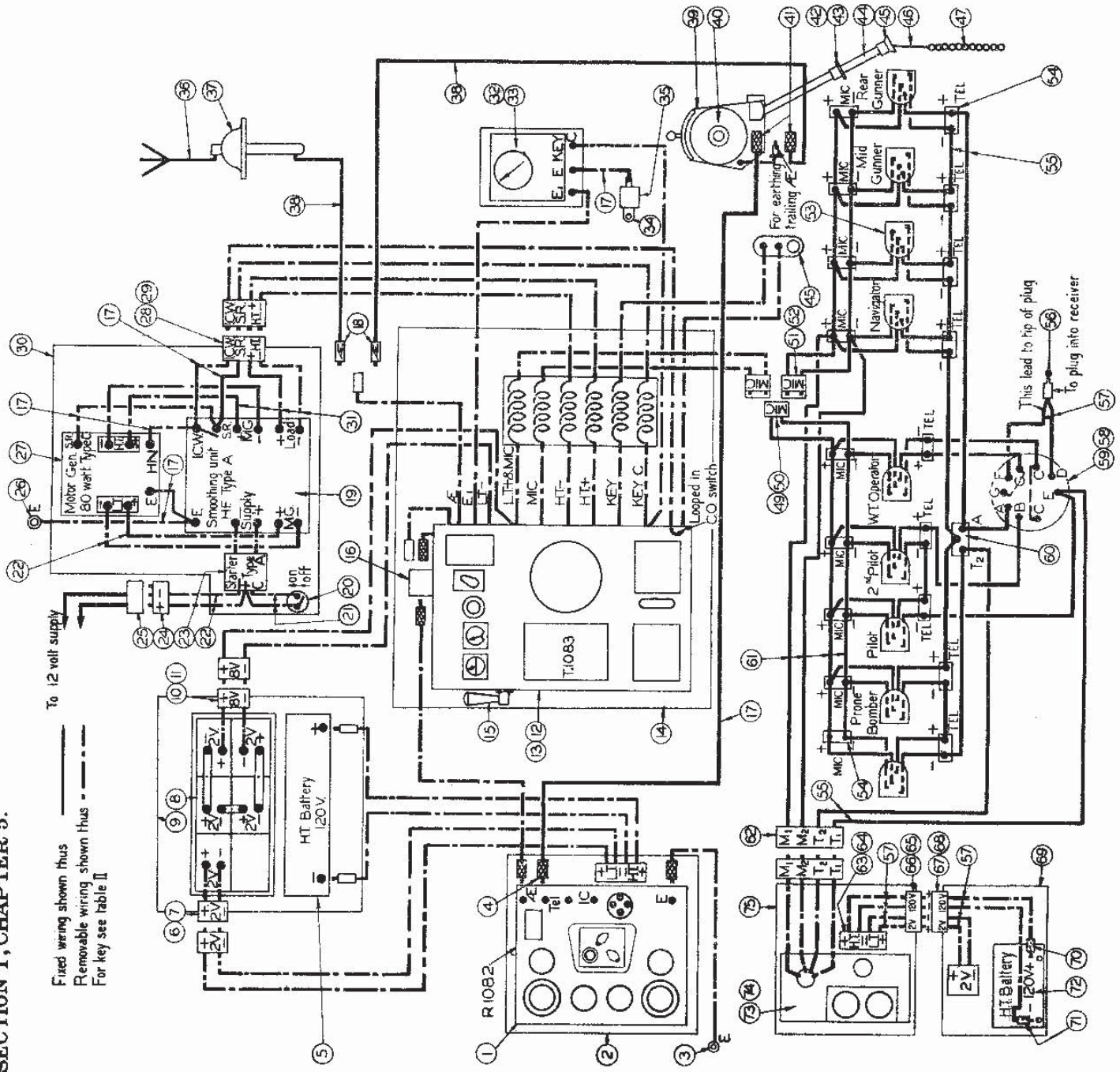


FIG. 16. INSTALLATION DIAGRAM (WITH 1/C)

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TABLE 2—*contd.*

Item No.	Ref. No.	Nomenclature.	Quantity.	Remarks.
14	N.I.V.	Crate transmitter	1	
15	10A/8050	Handle, operating, switch unit, type 2 ..	1	
16	10A/8474	Condenser unit, listening-through ..	1	
17	5A/916	Cable, L.T., unisheath 4, red-braided ..		As required.
18	10A/8118	Plug, type 62 (2-point, shielded) ..	2	
19	10A/8525	Smoothing unit H.F., type A ..	1	
20	5C/622	Switch, tumbler, 5 amp. ..	1	
21	5A/89	Cable, L.T., duflex 4, red-braided ..		As required.
22	5A/91	Cable, L.T., duflex 19, red-braided ..		As required.
23	10A/7997	Starter, type A	1	
24	N.I.V.	Plug, jacelite, 3-point, 5-amp. ..	1	Cat. No. 7110, Crabtree.
25	N.I.V.	Socket, jacelite, 3-point, 5-amp. ..	1	Cat. No. 7170, Crabtree.
26	10A/3387	Terminal, 2 B.A., type A, spring type ..	1	
27	10A/7532	Generator, motor, 80-watt, type C. ..	1	
28	10A/8533	Socket, type 42 (4-point) ..	1	
29	10A/8551	Disc indicating, type D	1	For 10A/8533.
30	N.I.V.	Crate, smoothing unit	1	
31	5A/81	Cable, H.T., uniplug 12, unbraided ..		As required.
32	10A/8475	Neutralizing unit	1	
33	5A/1385	Lamp filament, 4-V, 1.2 watts ..	1	For neutralizing unit.
34	10A/3387	Terminal, 2 B.A., type A, spring type ..	1	
35	10A/8473	Condenser unit, earth	1	
36	10A/4589	Aerial wire R.4		As required.
37	10A/8093	Aerial insulator, type 16, lead-in ..	1	
38	5A/82	Cable, H.T., noisepark 7, unbraided ..		As required.
39	10A/9005	Aerial winch, type 5, frame ..	1	
40	10A/9123	Aerial winch reel, type B. ..	1	
41	10A/8531	Socket, type 40 (S.P., H.T.) ..	2	
42	N.I.V.	Aerial fairlead tube clamp, floor. ..	1	
43	10A/7986	Aerial fairlead tube bush, insulating ..	1	
44	10A/216	Aerial fairlead tube, Dexine ..		Length as required.
45	10A/8913	Aerial fairlead bush, flared steel, type 3 ..	1	
46	10A/8235	Aerial wire, stainless steel 7/28 ..		For trailing aerial.
47	10A/7298	Aerial weight, bead type, No. 1 ..		
48	10A/7741	Key, Morse, type F	1	
49	10A/7437	Socket, type 19 (2-point)	1	
50	10A/7962	Disc indicating, type D.	1	For 10A/7437.
51	10A/8118	Plug, type 62 (2-point, shielded) ..	1	
52	10A/7961	Disc indicating, type D	1	For 10A/8118.
53	10A/7837	Socket 28 (Tel-Mic), series	9	
54	5C/430	Block terminal, type B 2-way, No. 1 ..	18	
55	5A/1353	Cable, L.T., unicel 4, black-braided ..		As required.
56	10A/488	Plug, type 1, Tel.	1	
57	5A/919	Cable, L.T., uniflex, red 4		As required.
58	10A/7275	Switch, type 25, I/C	1	
59	10A/7282	Switch, type 25, I/C base	1	
60	5C/432	Block terminal, type B, 3-way, No. 1 ..	1	
61	5A/1362	Cable, L.T., ducel 4, black-braided ..		As required.
62	10A/7283	Socket, type 12 (4-point)	1	
63	10A/7280	Plug, type 33 (4-point)	1	
64	10A/7265	Disc indicating, type A	1	For 10A/7280.
65	10A/8517	Plug, type 69	1	
66	10A/8908	Disc indicating, type F	1	For 10A/8517.
67	10A/8533	Socket, type 42	1	
68	10A/8909	Disc indicating, type F	1	For 10A/8533.
69	N.I.V.	Crate, I/C amp., batteries	1	
70	10A/8261	Plug, type 64 (S.P. battery)	1	
71	10A/8262	Plug, type 65 (S.P. battery)	1	
72	5A/1333	Battery, dry, 120-V, type A	1	For I/C amplifier.
73	10A/9130	Amplifier, I/C, type B	1	
74	5A/1548	Battery, dry, 3-V	3	For I/C amplifier grid bias.
75	N.I.V.	Crate, I/C amplifier	1	

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73. Referring to fig. 16 it will be seen that the main difference between this installation and that shown in fig. 15 is in the intercommunication arrangements. No connection is made from the transmitter side-tone system to the I/C socket on the receiver. The audio-frequency portion of the receiver is not, therefore, used for intercommunication but a separate amplifier, known as amplifier I/C, type B, is employed together with a 4-way switch; Switch, I/C Control, type 25. Nine positions are shown, each of which is provided with a microphone and telephone jack. Each of the occupants is provided with a flexible lead and plug connected to his microphone and telephone receivers, the plug being inserted in the appropriate jack. The I/C switch is provided with a two-way plug which is engaged with the telephone jack on the receiver, and the four positions of the switch are engraved I/C; I/C and W/T; W/T; I/C, W/T and PILOT. The amplifier, complete with the necessary transformers, switches and resistances, is contained in a canvas-covered wooden case and employs two valves (V.R.32 and V.R.19). One of the resistances is variable and serves as a volume control. A 120-volt dry battery is used for H.T., a 2-volt accumulator for L.T. and three 3-volt dry batteries are provided for grid bias. The L.T. and H.T. connections are made to the amplifier by means of one 4-way socket, and the connections between the amplifier and inter-communication system are made through another. An examination of the diagram will show that the microphone circuit may be broken at a plug and socket connection (49 and 51). When the plug and socket connection is made all the microphone circuits are in parallel on the intercommunication system but are not connected to the transmitter. By breaking this connection and connecting the socket (49) to the microphone plug on the transmitter, five of the occupants have their microphones connected to the transmitter and may thus transmit R/T. The remaining four who are not connected to the transmitter are, however, still left on the intercommunication system. The switch controls the telephone circuits only and operates in the following way. When the switch is in the I/C position all the telephone receivers are connected in series to the last stage of the amplifier, and there is no W/T reception. When the switch is moved to the I/C and W/T position, the telephones of the W/T operator are connected to the wireless receiver, while the telephones of the other occupants are all connected, in series with the I/C amplifier, across them. In the W/T position the W/T operator alone is on W/T reception, and all the other occupants are connected on the intercommunication system. In the fourth position of the switch the telephones of the W/T operator and the two pilots are connected in series across the wireless receiver, and the telephones of the other occupants are all connected, in series with the I/C amplifier, across the same circuit.

OPERATION

74. There are three methods of tuning the transmitter. Wavemeter W.1081 may be used, or the master-oscillator may be used as a standard, or receiver R.1082 may be used. When familiarity with the apparatus has been achieved the normal method will be by use of the master-oscillator as described in the following paragraphs.

136-500 kc/s

75. Connect the transmitter to a suitable aerial and set the ABCD switch to D. Set the grid-bias switch to TUNE, remove from the earth circuit the series earth condenser and plug in oscillator and amplifier coils (Range D). Set oscillator by calibration chart or by experience (see Tables 3, 4, 5 and 6), and set amplifier tuning, both rough and fine, to zero. Switch on receiver and transmitter L.T. and H.T. The M/O input should be about 20 mA. The M/O oscillatory current should be just readable.

76. If a standard trailing aerial is in use the rough tuning settings of oscillator and amplifier will be about the same. If this is remembered, the presence of harmonics need cause no confusion. It is not sufficient to use the coarse amplifier tuning, since this is merely a tapping switch. The fine tuning must also be used after selecting the nearest tapping.

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77. The neutralizing unit should now be set to TRANSMIT and the grid-bias switch set to C.W.1 or R/T.1. Check that total input is normal, not more than 70 mA, and check that aerial current is about 1 amp. Lock the controls and check I/C.

3-15 Mc/s

78. Connect the transmitter to a suitable aerial and set ABCD switch by calibration chart or experience (*see* Tables 3, 4, 5 and 6). Insert the series earth condenser (if necessary). Set the grid-bias switch to TUNE, the neutralizing unit to TUNE and the neutralizing condenser to zero. Insert the appropriate amplifier coil, choosing the anode tap A or B appropriate to the frequency. Set the amplifier coil to zero and set the AB switch on the base of the appropriate oscillator coil to correspond with the A or B anode tap. Now set the oscillator tuning and variometer, and the coupling coil by calibration chart or by experience. As a rough guide it may be said that if working near the highest frequency for which the selected anode tap is correct, a loose coupling is required; towards the bottom of the frequency range (of the selected anode tap) a tight coupling is required.

79. Switch on the receiver and switch on transmitter L.T. and H.T. The M/O input should be about 30 mA, and the oscillatory current about 1.5-2 amps. Tune the amplifier coil for maximum reading in the neutralizing ammeter. Harmonics may give false readings. Ensure that a true maximum is being used. Increase the setting of the neutralizing condenser until the neutralizing ammeter reads zero. Now set the neutralizing unit to TRANSMIT, and the bias switch to C.W.1. Press the key and slightly re-tune the amplifier coil for maximum aerial current. The total input should not exceed 70 mA. The aerial current should be about 2 amps. Slight adjustment of the coupling and slight retuning of the amplifier may increase the output. If using R/T, observe aerial ammeter for modulation. Lock the controls and check side tone and I/C.

80. To tune the transmitter by the wavemeter method, proceed as described in para. 78, and measure the transmitted frequency on W.1081. If in error, estimate the change required in oscillator setting, and repeat tuning from the beginning. This method should rarely be necessary.

81. To tune the transmitter to the frequency of a received signal making use of the receiver, tune the R.1082 to the "dead space" of the incoming signal (*see* appropriate chapter on R.1082). Reduce the volume considerably. Noting the approximate frequency, insert suitable coils in the transmitter. Set the ABCD switch, and put the bias switch to TUNE, switch on the transmitter H.T. and L.T. and tune the master-oscillator until its heterodyne note is heard in the receiver. Adjust the master-oscillator to the "dead space". Tune the amplifier to the master-oscillator in the usual way. The transmitter frequency should now be very close to that of the incoming signal. To cover any small error, make the first call on I.C.W. At the lower radio frequencies this method of tuning is very satisfactory, but above 5,000 kc/s the tuning of the master-oscillator becomes increasingly difficult due to frequency pulling, and care must be taken to keep the receiver gain down to the lowest practical value during these adjustments.

82. The amplifier grid-bias switch must be finally adjusted to give the necessary power. Never use more power than the circumstances require. On R/T, do not attempt to use studs 3, 4 or 5; in these positions a strong current with negligible modulation is transmitted, and the range is less than that obtainable on studs 1 or 2. The depth of modulation may be increased, and the range usually increased, by reducing the coupling between the oscillator and the amplifier.

PRECAUTIONS AND MAINTENANCE

83. Troubles in the transmitter are often quickly found by studying the indications on the four meters. For example, if in the tune position on range B an oscillator feed current of 45 mA. is observed and there is no oscillatory current, there is probably a break in the master-

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oscillator oscillatory circuit. Check pins and sockets F, G and H, or if there is no master-oscillator feed current, check that the H.T. is on to the transmitter, check H.T. contacts of S/R switch; check pins and sockets A, B, E and F.

84. If the master-oscillator is oscillating, but no aerial current is observed when tuning the amplifier, make sure that :—

- (i) the correct aerial is connected,
- (ii) the aerial and earth series capacitances are correct,
- (iii) the amplifier is not neutralized: the neutralizing condenser should be in the zero position.
- (iv) the fuse in the neutralizing unit is not blown,
- (v) the coupling coil tap is correctly set,
- (vi) the transmitter chassis is not earthed (*via* the front panel, perhaps).

85. If the amplifier appears to tune naturally, but the aerial current is low, the amplifier is probably tuned to a harmonic of the M/O. If the amplifier tunes at two adjacent points ("double hump") then the coupling is too tight. This may be reported by a receiving operator as a bad note, or as transmission on two frequencies. When the coupling coil setting is changed, the M/O. will usually require slight retuning.

86. The optimum setting of the ABCD switch and the use of the earth condenser are matters for experience on a particular aircraft and frequency. Earthing of the transmitter chassis will short-circuit the earth condenser.

87. Faults in the grid-bias switch might account for—

- (i) No anode current.
- (ii) Excessive anode current.
- (iii) Key short-circuited.
- (iv) No carrier when switched to R/T.
- (v) Intermittent failure of amplifier.

88. If, in an emergency, only one V.T.25 is available, and transmission on range A, B or C is likely to be useful, put the serviceable valve in the amplifier stage. Plug in the appropriate coils with their usual settings for the desired frequency. If available, put the discarded valve in the oscillator stage. Put the G.B. switch to C.W.I. Set the neutralizing condenser to zero or 100°, and the amplifier will probably oscillate near the desired frequency.

89. Ensure, while sending dots, that the anode current is not excessive, and that the better extreme setting of the neutralizing condenser has been chosen. Make the first call on I.C.W. The presence of the oscillator coil and of the discarded valve ensures that the frequency calibrations hold fairly well. If a wavemeter is available the valve and coil are unnecessary. Without them, the amplifier can be made to oscillate over a wider band. If the neutralizing unit fuse or meter is blown, tune on the aerial ammeter with the G.B. switch at "tune" and the neutralizing unit at "transmit".

90. If the L.T. voltage is badly down, both power and frequency stability will be reduced. If the M.G. input voltage is badly down, starter, type A will run the M.G. at half speed only. If the input voltage to the M.G. is much above 14 volts, there is a slight risk on range D of a breakdown of aerial circuit insulation. Set transmitter to C.W.I. Beware of reversed polarity at M.G. input terminals.

91. It should be remembered that the neutralizing unit is in the lead between the earth terminal of the transmitter and the earth connection of the installation. An accidental earth on the transmitter will, therefore, short-circuit the neutralizing unit. Such a short-circuit may

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occur if the suspension of the transmitter is allowed to sag and cause the metalwork of the master-oscillator chamber to touch an "earthed" part of the installation. As a consequence, tuning with the neutralizing switch in the tune position will be rendered difficult if not impossible.

92. The microphone transformer (4) shown in fig. 9 has four soldering tags punched into the terminal strip. Some transmitters (serial Nos. 1260-1630) have, in addition, four 8 B.A. nuts and bolts through the strip. The presence of these nuts and bolts constitutes a potential source of insulation failure. The transmitter should be inspected and if these nuts and bolts are present they should be removed from the terminal strip. Difficulty may occur in starting the thread, and it is essential for the whole instrument and nut to be firmly held while bearing on the bolt, and also to ensure that the soldering tags in the terminal strip are not loosened.

93. The microphone transformer has been found to fail under sea-going conditions, for example when the transmitter is used with the Fleet Air Arm. Since R/T is not required in these circumstances, the transformer may be put out of action by short-circuiting the secondary winding with a piece of 16 s.w.g. copper wire. Before the transmitter is returned to stores, the short-circuit should be removed.

94. Owing to certain insulation failures, a number of modifications have been made to the coils and general transmitter wiring. These modifications are in all cases in the nature of constructional details. Except for these changes, the transmitter is exactly as described in the earlier paragraphs. To provide against the eventuality of an earth occurring on the MIC-TEL circuit, a fuse is now inserted in the positive L.T. lead between the switch terminal engraved LT + & MIC and choke unit, as shown in fig. 7.

TABLE 3
Typical Calibrations of T.1083
Taken on a Swordfish Aeroplane
Range D. Aerial : 200 feet trailing.
"ABCD" Switch : D.
Earth Condenser Unit not in circuit.

Frequency kc/s.	Master-Oscillator.		Amplifier.		Input (mA.).	Output (I _{AE}).
	Coarse.	Fine.	Coarse.	Fine.	G.B. switch at C.W.5.	
132	14	5.5	14	3.4	58	.9
137	13	5.5	13	4.5	60	1.0
144	12	5.5	12	5.2	60	1.0
149	11	5.5	11	5.5	60	1.0
160	10	5.5	10	5.8	60	1.0
170	9	5.5	9	5.8	57	1.05
184	8	5.5	8	5.9	57	1.1
200	7	5.5	7	5.9	55	1.1
223	6	5.5	6	5.8	57	1.2
252	5	5.5	5	5.6	57	1.2
295	4	5.5	4	5.6	57	1.25
358	3	5.5	3	5.4	50	1.2
412	2	5.5	2	5.3	60	1.25
475	1	5.5	1	5.2	55	1.2

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TABLE 4

Range C. Aerial : Fixed. Three-limbed umbrella

Frequency Mc/s.	Master-Oscillator		Coupling and Anode Tap.	Neut. Cond.	Bias C.W.	ABCD.	Amplifier Turns.	Earth Cond.	Input mA.	Output Amps.
	Turns.	Vario.								
2.98	17.240		B 9	36	4	D	16.200	Dis.	65	1.7
3.16	15.180		B 8	36	4	D	15.200	Dis.	65	2.0
3.25	14.180		B 7	34	4	D	14.140	Dis.	65	2.0
3.35	13.180		B 6.5	32	4	D	13.210	Dis.	65	2.0
3.44	12.180		B 6	32	4	D	12.310	Dis.	65	2.0
3.55	11.180		B 5.5	30	4	D	12.400	Dis.	65	2.1
3.67	10.180		B 5	30	5	D	11.120	Dis.	65	2.2
3.83	9.180		B 4	28	5	D	10.200	Dis.	65	2.2
3.98	8.180		B 2.5	28	5	D	9.220	Dis.	65	2.2
4.15	7.180		A 9	30	4	D	9.120	Dis.	65	2.1
4.35	6.180		A 8	30	4	D	8.500	Dis.	65	2.1
4.62	5.180		A 7	30	4	D	7.800	Dis.	65	2.2
4.86	4.180		A 6	26	4	D	6.120	Dis.	65	2.2
5.20	3.180		A 5	26	4	D	5.160	Dis.	65	2.2
5.54	2.180		A 4	26	3	D	4.196	Dis.	65	2.0
5.92	1.180		A 3	22	4	C	5.500	Dis.	65	1.9
6.12	1.000		A 2	22	4	C	4.180	Dis.	65	1.6

TABLE 5

Range B. Aerial : Fixed. Three-limbed umbrella

Frequency Mc/s.	Master-Oscillator		Coupling and Anode Tap.	Neut. Cond.	Bias C.W.	ABCD.	Amplifier Turns.	Earth Cond.	Input mA.	Output Amps.
	Turns.	Vario.								
5.7	15.000		B 9	62	4	C	8.320	In	65	1.75
5.95	13.180		B 7.5	60	4	C	7.330	In	65	1.6
6.13	12.180		B 7	60	4	C	7.160	In	65	1.6
6.30	11.180		B 6	58	4	C	6.320	In	65	1.55
6.55	10.180		B 5	56	3	C	6.110	In	65	1.5
6.80	9.180		B 4	56	3	C	5.360	In	65	1.5
7.20	8.180		B 2	56	4	C	5.300	In	65	1.5
7.5	7.180		A 9	66	4	C	4.200	In	65	1.5
7.94	6.180		A 8	68	4	C	3.260	In	65	1.5
8.42	5.180		A 7	68	4	C	2.240	In	65	1.5
9.00	4.180		A 6	68	4	C	2.000	In	65	1.5
9.72	3.180		A 4	68	4	B	1.120	In	65	1.4
10.30	2.180		A 2	68	3	B	0.140	In	70	1.0

TABLE 6

Range A. Aerial : Fixed. Inverted L ; transmitter to fin, 12 feet.

Aerial series condenser : A.

Earth condenser unit in circuit.

Bias : C.W.5.

Frequency Mc/s.	M.O. Turns.	Coupling and Anode Tap.	Neutralizing Condenser.	Amplifier Turns.	Input mA.	Output Amps.
9.88	12.80	B 10	50	6.340	55	1.3
10.09	11.180	B 9	50	6.200	55	1.4
10.40	10.180	B 8	48	6.30	56	1.4
10.83	9.180	B 7	48	5.20	56	1.4
11.24	8.180	B 6	46	5.0	56	1.4
11.67	7.180	B 5	46	4.140	56	1.4
*12.24	6.180	*B 4	44	3.280	60	1.3
*12.59	6.180	*A 8	42	3.240	60	1.2
13.20	5.180	A 7	42	3.50	60	1.2
13.98	4.180	A 5	42	2.130	60	1.2
14.50	3.340	A 4	44	1.320	60	1.2
15.10	3.70	A 3	44	1.80	65	1.0

* Note change of M.O frequency with change of coupling coil tap.

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APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. In ordering spares for this transmitter, the appropriate Section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks
10A/8456	Transmitter T.1083		Without valves, coils or switch unit.
	Principal components :—		
	Ammeter, thermo :—		
10A/8479	0-2.5, type B	1	Aerial.
10A/8480	0-3, type B	1	Master-oscillator.
10A/8457	Bar, contact	1	With 13 contacts.
10A/8458	Case	1	
	Choke, H.F. :—		
10A/8482	Type R	1	
10A/8483	Type S	1	
10A/8484	Type T	1	
	Condenser :—		
10A/8044	Type 139	1	.01 μ F.
10A/8045	Type 140	1	.022 μ F.
10A/8048	Type 143	1	.001 μ F.
10A/8493	Type 185	2	.004 μ F.
10A/8496	Type 188	1	.01 μ F.
10A/8497	Type 189	2	.0003 μ F.
10A/8498	Type 190	1	.000075 μ F.
10A/8499	Type 191	1	.002 μ F.
10A/8500	Type 192	2	.0001 μ F.
10A/8501	Type 193	1	.00003 μ F. (max.)
10A/9870	Type 344	2	0.5 μ F.
10A/8459	Cover, end	1	With contact bar.
10A/3412	Holder, valve, V.T.13	2	
10A/8514	Milliammeter :—		
	0-150, type B	1	
	Resistance :—		
10A/8522	Type 148	5	2,000 ohms each.
10A/8523	Type 149.. .. .	3	6,600 ohms each.
10A/8524	Type 150.. .. .	1	40,000 ohms.
10A/8570	Type 152.. .. .	1	500 ohms.
10A/8537	Switch, type S5	1	Series aerial condenser.
10A/8539	Transformer, microphone, type H	1	
10A/8460	Unit, grid-bias	1	
	Accessories :—		
10A/8571	Case, stowage, coils	8	One case takes one M/O or one amplifier coil.
	Case, transit :—		
10A/8461	Coil	1	
10A/8462	Transmitter	1	
	Coil :—		
	Amplifier :—		
10A/8465	Range A	1	15,000 to 10,000 kc/s.
10A/8466	Range B	1	10,000 to 6,000 kc/s.
10A/8467	Range C	1	6,000 to 3,000 kc/s.
10A/8468	Range D	1	500 to 136 kc/s.
	Master oscillator :—		
10A/8469	Range A	1	15,000 to 10,000 kc/s. Fitted with coupling coil and one each types 196 and 200 condensers.

APPENDIX—continued

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter T.1083— <i>continued</i>		
	Accessories— <i>continued</i> .		
	Master-oscillator— <i>continued</i> .		
10A/8470	Range B	1	10,000 to 6,000 kc/s. Fitted with one each range B variometer and type 193 condenser.
10A/8471	Range C	1	6,000 to 3,000 kc/s. Fitted with coupling coil and one each range C variometer and type 194 condenser.
10A/8472	Range D	1	500 to 136 kc/s. Fitted with one each types 142, 197, 198 and 199 condensers.
10A/8534	Switch unit (unwired)	1	Send-receive.
10A/7312	Valve :— Type V.T.25	2	One M/O and one amplifier.
	Accessories, installation :—		For use when T.1083 is used together with R.1082.
10A/8559	Aerial, artificial	1	For ground setting-up of T.1083.
10A/8487	Aerial, screened loop	1	For D/F with R.1082.
	Choke unit :—		
10A/8463	Filament	1	For use with 12-V filament supply.
	Controls, remote, comprising :—		
10A/8580	Adaptor, ring, change-over switch ..		On which a switch coupling, type E, is mounted.
10A/8189	Casing, flexible, type C		
10A/8190	Casing, rigid, type C		
10A/8585	Cleat, type C		For securing casing rigid to aeroplane structure.
10A/8187	Control switch and tuning, type C ..		
10A/8592	Coupling, pedestal	}	For remote control of coil, anode, S.50, on R.1082.
10A/8590	Coupling, tuning		For use with 10A/9119.
10A/4178	Gun, lubricator, type B		For use with union, casing, type B.
10A/9515	Pin, key, type C		
10A/8192	Shafting, flexible, type C		
10A/8745	Switch, type 89		Mounted on underside of switch, coupling.
10A/8746	Switch, coupling, type E	2	For "send-receive".
10A/8193	Union, casing, type B		Quantity as required.
10A/9119	Union, lubricating, type C		Quantity as required.

FOR OFFICIAL USE ONLY

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Volume I

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TRANSMITTER T.1090

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TRANSMITTER T.1090

(Stores Ref. 10A/9337)

INTRODUCTION

1. The transmitter T.1090 is a mobile ground station transmitter, designed to meet the requirements of Army Co-operation work and is intended more particularly for use in tenders. The transmitter is capable of radiating C.W., I.C.W. and R/T. The frequency bands covered are 6,667 to 1,222 and 857 to 545 kc/s, these bands sub-divided into five ranges by means of plug-in coils as follows:—

Range A	..	..	4,286 to 6,667 kc/s.
Range B	..	..	3,000 to 4,615 kc/s.
Range C	..	..	2,000 to 3,409 kc/s.
Range D	..	..	1,222 to 2,069 kc/s.
Range E	..	..	545 to 857 kc/s.

2. The transmitter employs a master-oscillator circuit of the Hartley type, capacitance-coupled to an amplifier circuit with tuned anode. The aerial circuit is inductively coupled to the amplifier circuit. Neutralizing is employed in order to avoid "feed-back" into the

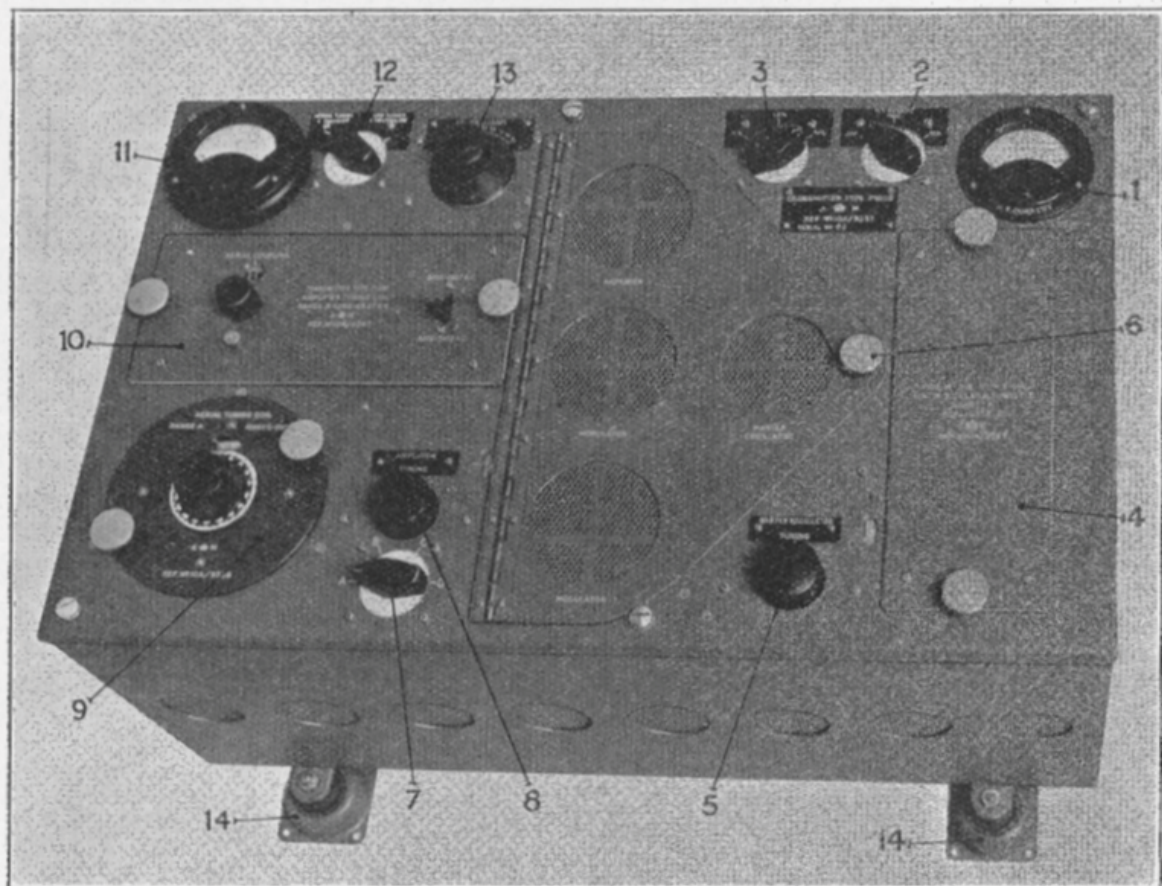


FIG. 1. Transmitter T. 1090.

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master-oscillator circuit. Modulation is obtained by choke control. Four type V.T.25 valves are used, one as a master-oscillator, one as an amplifier, and two in parallel serve as modulator valves on R/T.

3. The transmitter has been designed so that the grid biasing equipment is external to the instrument itself, thus any form of biasing may be employed such as grid-bias battery or "automatic" bias. The weight of the transmitter including valves and one set of coils is about 41 lb. and the overall dimensions are approximately $23\frac{1}{2}$ in. $\times$ $11\frac{1}{2}$ in. $\times$ 16 in.

4. In order to provide for different aerial systems two positions are provided for the aerial plug. One enables the aerial circuit to be tuned on fairly small aerials at the lower frequency end of the band, and the other enables tuning to be performed on larger aerials at the higher frequency end of the band. In order to extend the scale of the amplifier tuning condenser, three fixed condensers can be added by means of a four-position switch. Each of these condensers has a capacitance slightly less than the tuning condenser.

5. A selector switch is provided which enables C.W., I.C.W., or R/T to be used. Another selector switch enables the valve anode currents to be read on the same milliammeter. The switch is engraved AMP, MOD, and M/O, and when moved into one or other of these positions it switches the milliammeter into the anode circuit of the corresponding valve.

6. The L.T. supply required is 8 volts and the H.T. voltage depends upon the power required. If the transmitter is working on full load (approximately 200 watts), the H.T. supply will have to be of the order of 1,500 volts. When a lower power output is employed the H.T. voltage must be reduced.

GENERAL DESCRIPTION

Transmitter

7. A theoretical circuit diagram of the transmitter, with the coils for range A in position, is given in fig. 2. V_2 is the master-oscillator valve, V_1 the amplifier valve and V_3 and V_4 the modulator valves. The master-oscillator inductance L_3 is tuned by means of the condenser C_{12} , and the H.T. feed is made through the R/F choke L_5 and the resistance R_4 . The master-oscillator is capacitance-coupled to the amplifier through the condenser C_6 .

8. The anode inductance L_2 of the amplifier circuit receives its H.T. feed through the iron-cored choke L_6 and the R/F choke L_4 , and a portion of the inductance is tuned by means of the variable condenser C . The lower portion of the inductance is a neutralizing winding and is connected through the variable condenser C_4 to the grid of the amplifier valve. The aerial coil L which is tuned by varying its inductance, is connected in series with a coupling coil L_1 situated in the amplifier unit. The coupling of the coil L_1 to the amplifier anode coil is capable of variation.

9. The modulator valves V_3 and V_4 are in parallel and the anodes are fed with H.T. through the iron-cored choke L_6 . The primary of the transformer T is connected in series with the microphone across the filament supply. One end of the secondary is connected to the socket engraved B, while the grids of the modulator valves are connected to the socket engraved A. It is thus possible to employ the transformer T by short-circuiting A and B, or to use an external matching impedance by connecting it across A and B.

10. There are four drum-type switches in the transmitter. The switch S_1 is for the purpose of extending the tuning range of the amplifier. This switch has four positions engraved A, B, C and D. In position A (shown in the diagram), the variable condenser C only is connected across the amplifier inductance. In position B the fixed condenser C_1 is added. In position C condensers C_1 and C_2 are added and in position D condensers C_1 , C_2 and C_3 are added.

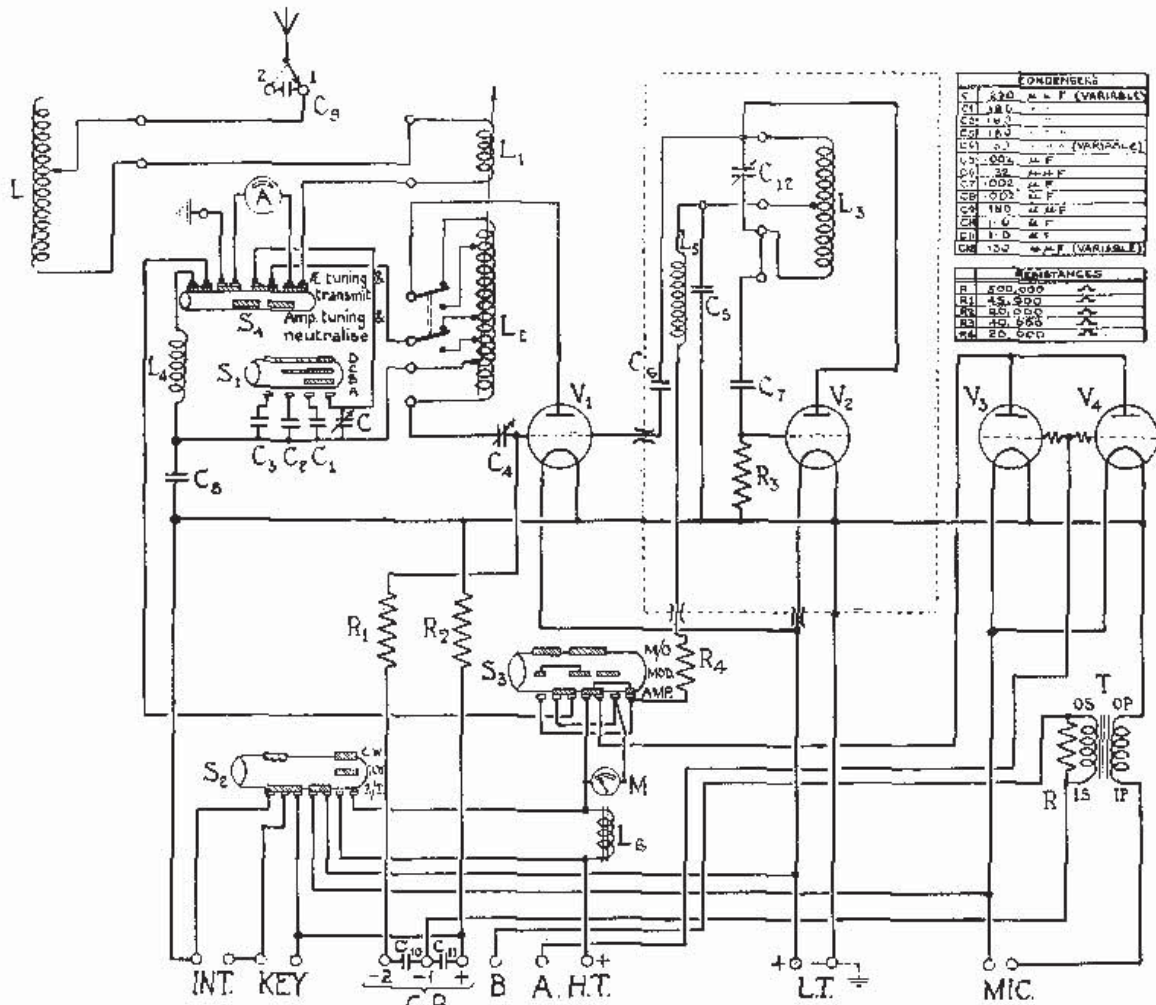


FIG. 2. Theoretical circuit diagram.

11. The switch S_2 is for the purpose of changing over from C.W. to I.C.W. or R/T. The switch is shown in the R/T position and it will be seen that the three left-hand contacts are bridged, short-circuiting the key and interrupter. The next two contacts are also bridged closing the filament circuit of the modulator valves, across which is connected the primary of the microphone transformer. When the switch is moved into the I.C.W. position the bridging connection is removed from the three left-hand contacts and the key and interrupter are put into circuit. The bridging connection is also removed from the modulator valve filament circuit, thus opening this circuit. At the same time the two right-hand contacts are closed, short-circuiting the modulator choke. In the C.W. position the two left-hand contacts and the two right-hand contacts are bridged. As a result the interrupter is short-circuited but the key is left in circuit. The modulator filament circuit is opened and the modulator choke short-circuited.

12. The switch S_3 is provided to enable a single milliammeter to read the anode current in the master-oscillator, the modulator or the amplifier circuits. It has three positions engraved M/O, MOD and AMP. In the diagram it is shown in the "AMP" position, and it will be seen that the H.T. supply has a common path through the modulator choke, after which the amplifier branch passes through the milliammeter M, whilst the supplies to the master-oscillator and modulators are taken direct from the choke. When the switch is moved into the MOD position the amplifier and master-oscillator H.T. supplies are taken direct from the choke, and the modulator H.T. current only passes through the milliammeter. Similarly when the switch is moved into the M/O position the master-oscillator H.T. current passes through the milliammeter and the modulator and amplifier H.T. currents do not.

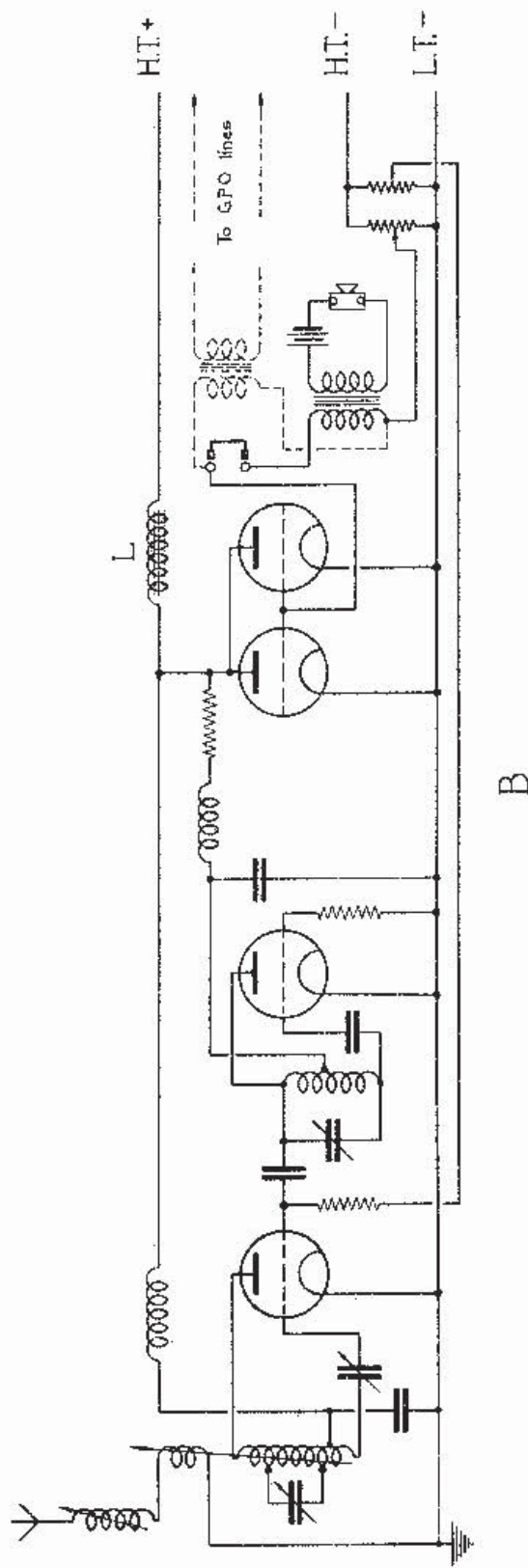
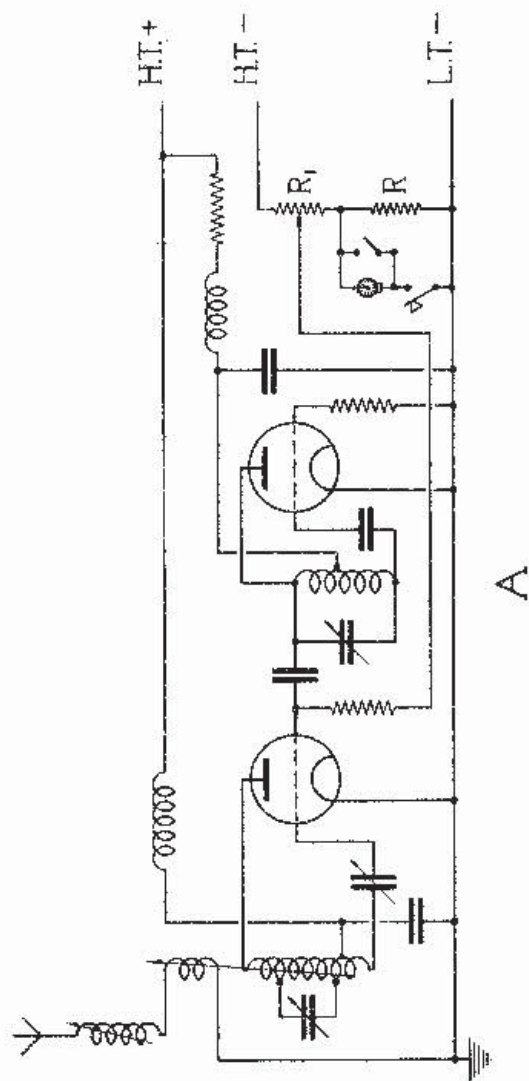


FIG.3. SCHEMATIC DIAGRAM. T.1090

Facing pages 13-15.

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13. The switch S_4 has two positions engraved AE TUNING AND TRANSMIT and AMP TUNING AND NEUTRALIZE. It is shown in the first-mentioned position, and it will be seen that the two left-hand contacts are in the amplifier H.T. feed circuit and that this circuit is completed only when the switch is in the position shown. An examination of the connections of the next two contacts will show that one is earthed and the other is connected to the ammeter. One side of the ammeter is thus earthed in this position of the switch. If the circuit of the ammeter is traced through, it will be seen that it is connected (at the right-hand pair of contacts) to the aerial coupling coil and therefore measures the aerial current. The remaining pair of contacts on the switch is also bridged in this position, and it will be seen that the effect is to connect the variable condenser C across the tunable portion of the amplifier inductance. When the switch is moved into its alternative position the left-hand pair of contacts is opened, breaking the H.T. supply to the amplifier. The second pair and the right-hand pair are broken, disconnecting the ammeter from the aerial circuit. The bridge is removed from the remaining pair and the ammeter substituted. The ammeter is thus connected in series in the tuned circuit of the amplifier.

14. A schematic diagram of the transmitter employing the automatic grid-bias is given in fig. 3. The upper part of the illustration (fig. 3A) shows the circuit arrangements for C.W. or I.C.W., while the lower portion (fig. 3B) shows the circuit arrangements for R/T. It will be seen that the R/F portion of the circuit is the same for both arrangements. A master-oscillator circuit of the Hartley type is employed and is capacitance-coupled to an amplifier circuit. The variable aerial inductance is provided with a series coil which is coupled to the amplifier inductance. Frequency instability due to feed-back is obviated by the provision of a neutralizing winding on the amplifier inductance. A resistance is included in the anode circuit of the master-oscillator valve to reduce the supply voltage to the required value. The anode circuit of the M/O and amplifier valves are provided with R/F chokes.

15. Referring to the upper portion (fig. 3A) which shows the arrangements for C.W. or I.C.W., it will be seen that the modulator valves, and the choke (L , fig. 3B) are not used. For keying

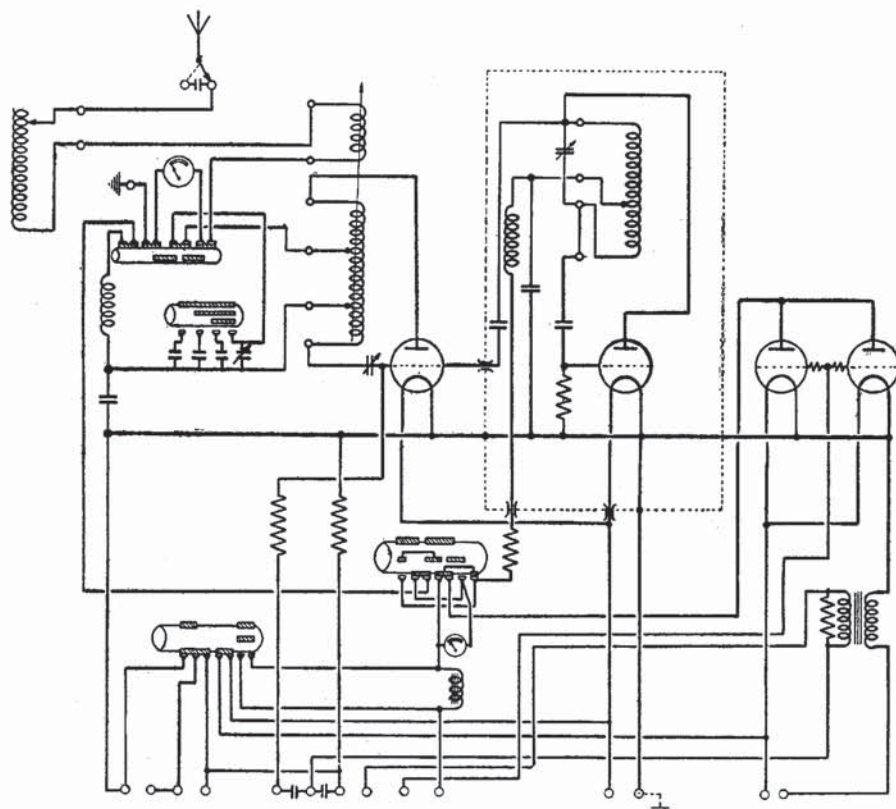


FIG. 4. Theoretical circuit diagram (Range B).

purposes a resistance R is included in series with the automatic bias resistance between H.T.— and L.T.—. The key circuit including the interrupter, is connected across the resistance. When the key is depressed the resistance is short-circuited. When the key is raised heavy negative bias is applied to the amplifier valve and at the same time the anode voltage is reduced. It will therefore be seen that the effect of the resistance, when in circuit, is to “shut down” the amplifier valve.

16. The lower part of the illustration (fig. 3B) shows the circuit employed on R/T. It will be seen that the two modulator valves are connected in parallel, the choke control method of modulation being used. For this purpose the iron-cored choke L is provided in the anode circuit of the modulator valves. It will be observed that, unlike other service transmitters, the H.T. feed to both oscillator and amplifier is taken *via* the modulator choke. The grid-bias for the amplifier and both modulators is obtained from the automatic grid-bias unit. This consists of two resistances connected in parallel between H.T.— and L.T.—, bias for the amplifier being obtained from one of the resistances and bias for the modulators being obtained from the other. A grid-leak resistance is provided in the amplifier grid circuit. As shown in the diagram the common grid circuit of the modulator valves is brought to one of a pair of sockets. The other socket is connected through the secondary of a microphone transformer to the appropriate resistance on the automatic grid-bias unit. In order to connect the transmitter to a line for remote modulation, arrangements have been made to enable the circuit to be changed as shown by the dotted lines. In this event a special matching impedance unit is used. Connections to this impedance unit are made by means of plugs and sockets. When the unit is not being used, the two ends of the transformer secondary winding are disconnected, and the two sockets are then short-circuited.

Coils

17. The diagram in fig. 2 gives the transmitter circuit with the range A coils (4,286 to 6,667 kc/s) in position. The circuits for ranges B (3,000 to 4,615 kc/s), C (2,000 to 3,409 kc/s), D (1,222 to 2,069 kc/s) and E (545 to 857 kc/s), are given in figs. 4, 5, 6 and 7.

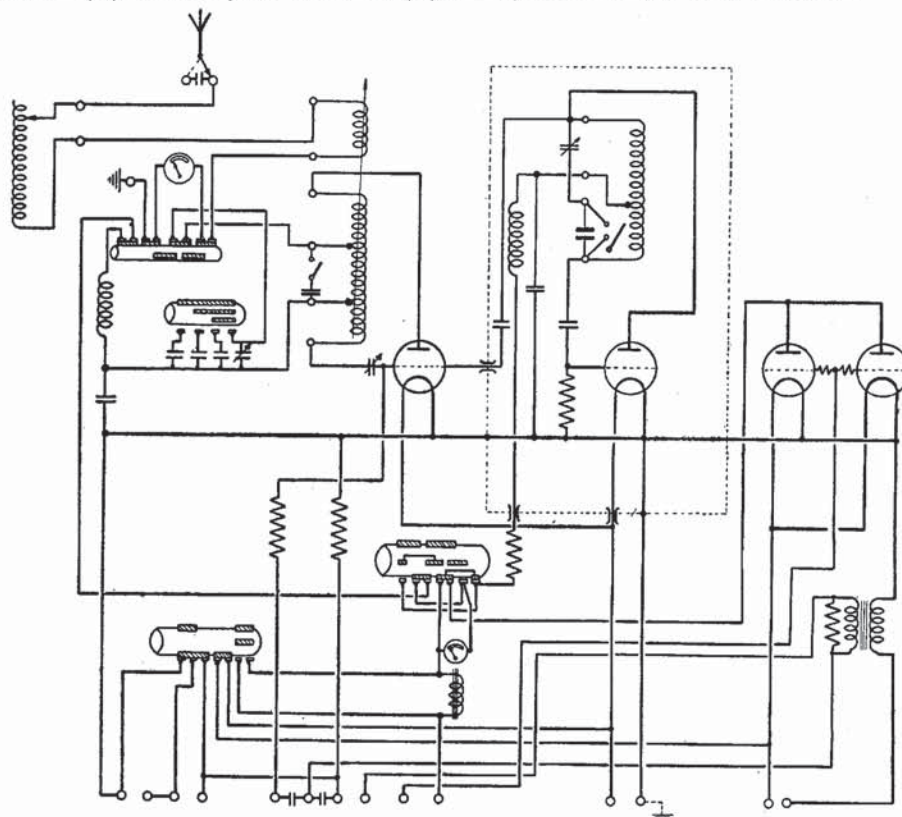


FIG. 5. Theoretical circuit diagram (Range C).

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18. Referring to fig. 4 it will be seen that the substituted aerial coil for the range B is of the same form (variable tapping) but it has a different maximum inductance value. The amplifier anode circuit differs from that used in range A in that no switch is provided for changing the tapping point, the required frequency cover being obtained entirely by means of the variable condenser. The master-oscillator unit is of similar construction, except that the tapping point is changed.

19. As shown in fig. 5, the range C aerial circuit is similar but the amplifier unit, in addition to having a different value of inductance, has a fixed condenser which may be switched into circuit across the tuned portion of the winding in addition to the existing variable condenser. The master-oscillator coil has an additional condenser which may be switched in series with the tuning condenser.

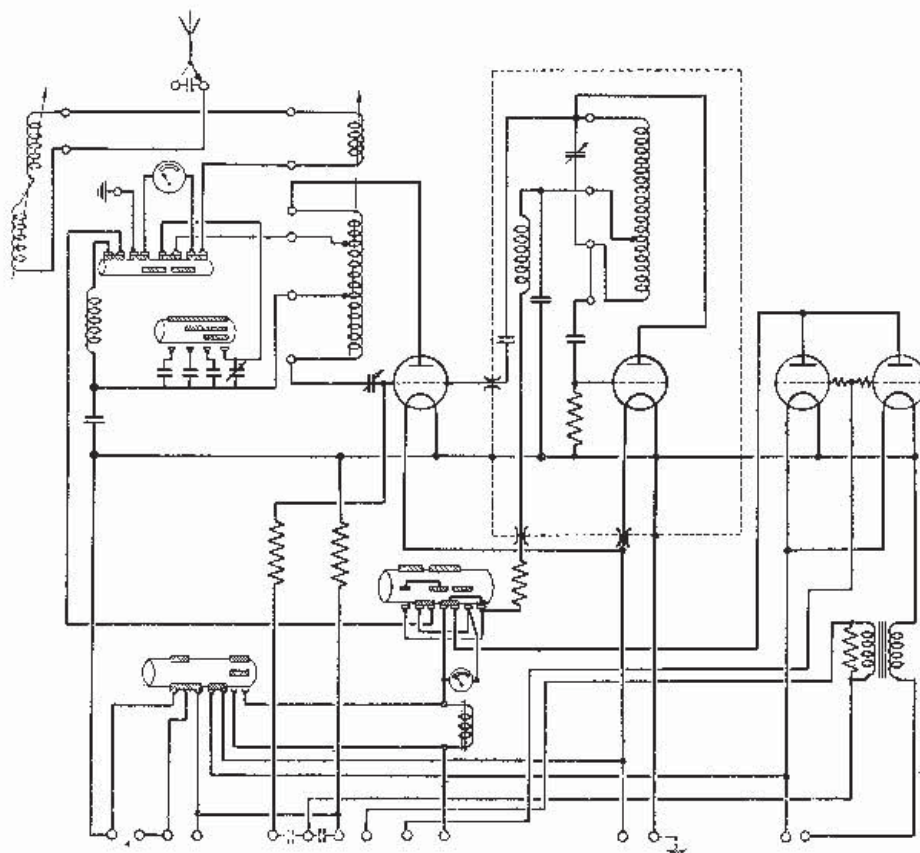


FIG. 6. Theoretical circuit diagram (Range D).

20. On range D (fig. 6) the aerial coil differs from the previous form of construction in that instead of a tapped inductance, the variometer principle is employed. The amplifier coil differs only as regards inductance value, while the master-oscillator coil is of the same form as the A and B ranges but has a different value of inductance.

21. Referring to fig. 7, the aerial and amplifier units for the range E coils are of the same form as for the previous range. The master-oscillator coil in addition to having a different value of inductance has two fixed condensers in series connected across the winding.

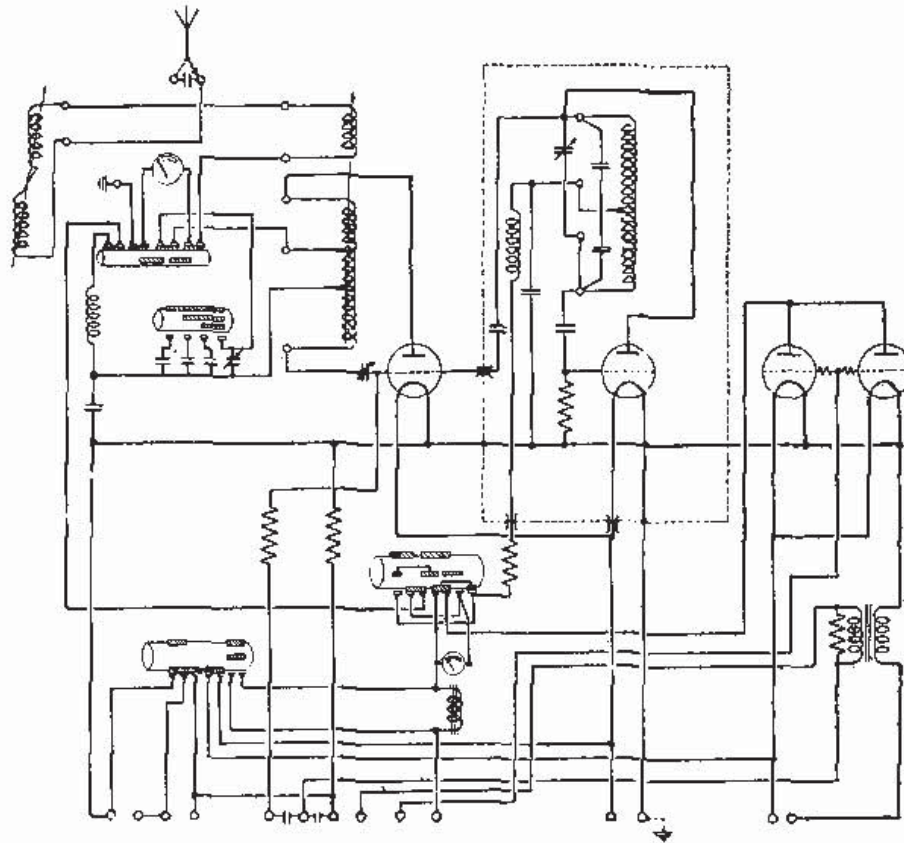


FIG. 7. Theoretical circuit diagram (Range E)

Automatic grid-bias unit

22. This unit has been designed for use with the transmitter as an alternative to bias batteries. It provides bias for both modulator and amplifier valves. The negative voltages required for this purpose are obtained from the H.T. generator by the use of resistances in series with the H.T. negative connection to the filaments. Variable taps on these resistances select suitable voltages (negative with respect to the filaments) for application to the grids of the valves.

23. Referring to fig. 8, in order to give separate and continuously variable values of grid-bias for the two sets of valves, two resistances are arranged in parallel, one common connection going to the terminal engraved H.T.—, the other to the terminal engraved G.B.—. The variable tappings are taken to the grids of the modulator and amplifier valves, *via* the terminals engraved G.B.— 1 and G.B.— 2 respectively.

24. Each resistance has a nominal value of 3,500 ohms giving a maximum bias of 250 volts when the transmitter is on full load. The bias for either the modulators or amplifier is selected by setting the appropriate dial according to the figures given in the Tables.

25. The power absorbed by the bias resistances from the H.T. generator is approximately 35 watts when 1,500 volts is applied to the transmitter. The unit is capable of giving finer adjustments than the battery bias and has the further advantage that no maintenance is required.

Side-tone unit type D

26. A circuit diagram of the side-tone unit is given in fig. 9. The three condensers C , C_1 and C_2 are in series and are connected between aerial and earth of the transmitter. The total capacitance is small enough to prevent appreciable energy being taken from the transmitter.

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Across one of these condensers (C_2) is connected a copper-oxide rectifier of the "Westector" type, and audible response is obtained in a pair of telephones connected across the latter when modulation at audio-frequencies is taking place.

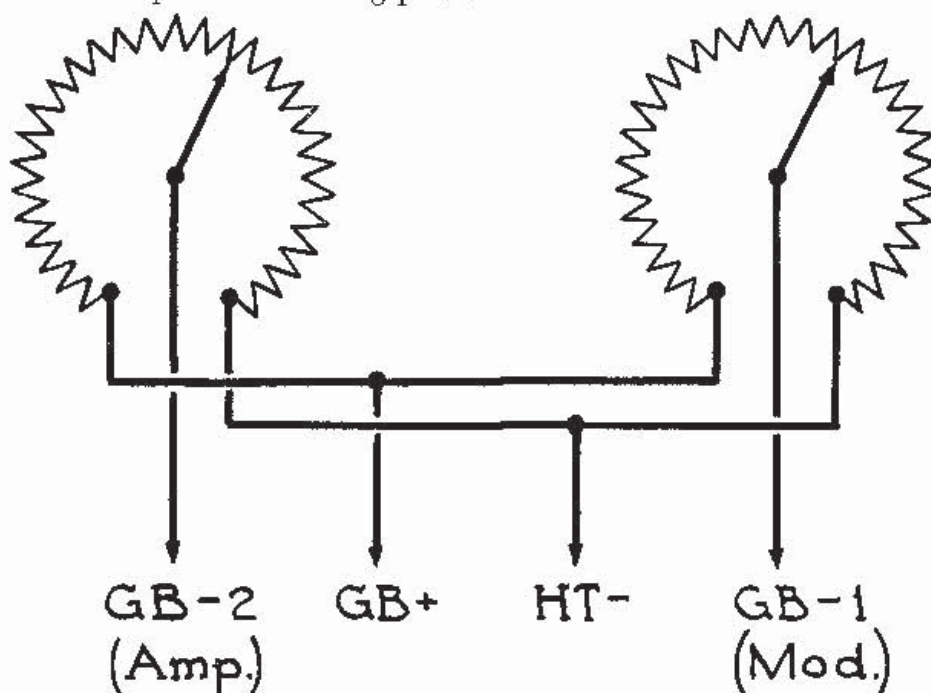


Fig. 8. Theoretical circuit diagram. (Automatic grid-bias unit.)

27. The unit has been so designed that the telephone receivers, while in use with the unit, remain connected to the output of the receiver at the same time. This is accomplished by providing two telephone jacks (J and J₁). The jack J₁ is connected to the receiver output by means of a length of cable terminating at each end in a plug. One of these plugs is engaged in the jack J₁ and the other in the jack of the receiver. The telephones in use are plugged into jack J. Since the rectifier circuit forms a permanent shunt path across the telephones during reception, a resistance R is connected in series to prevent reduction of signal strength.

28. A second resistance R_1 also in series in this circuit is provided with a switch S to enable two different degrees of loudness of side-tone signals to be obtained. When the switch S is closed the total resistance in series with the telephones is .25 megohm, and when the switch

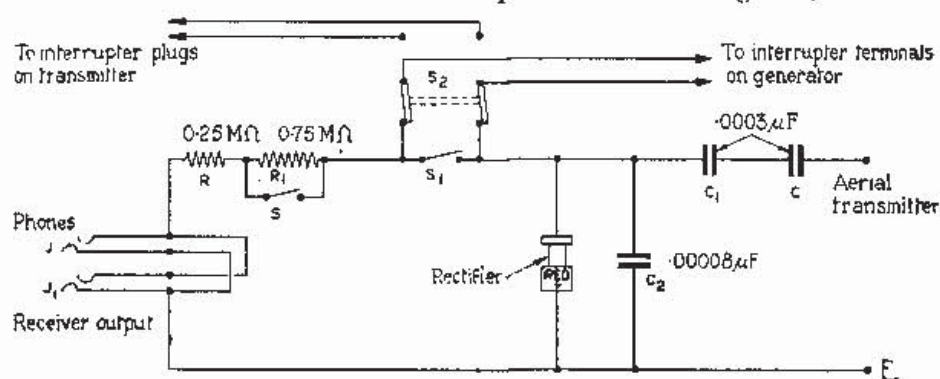
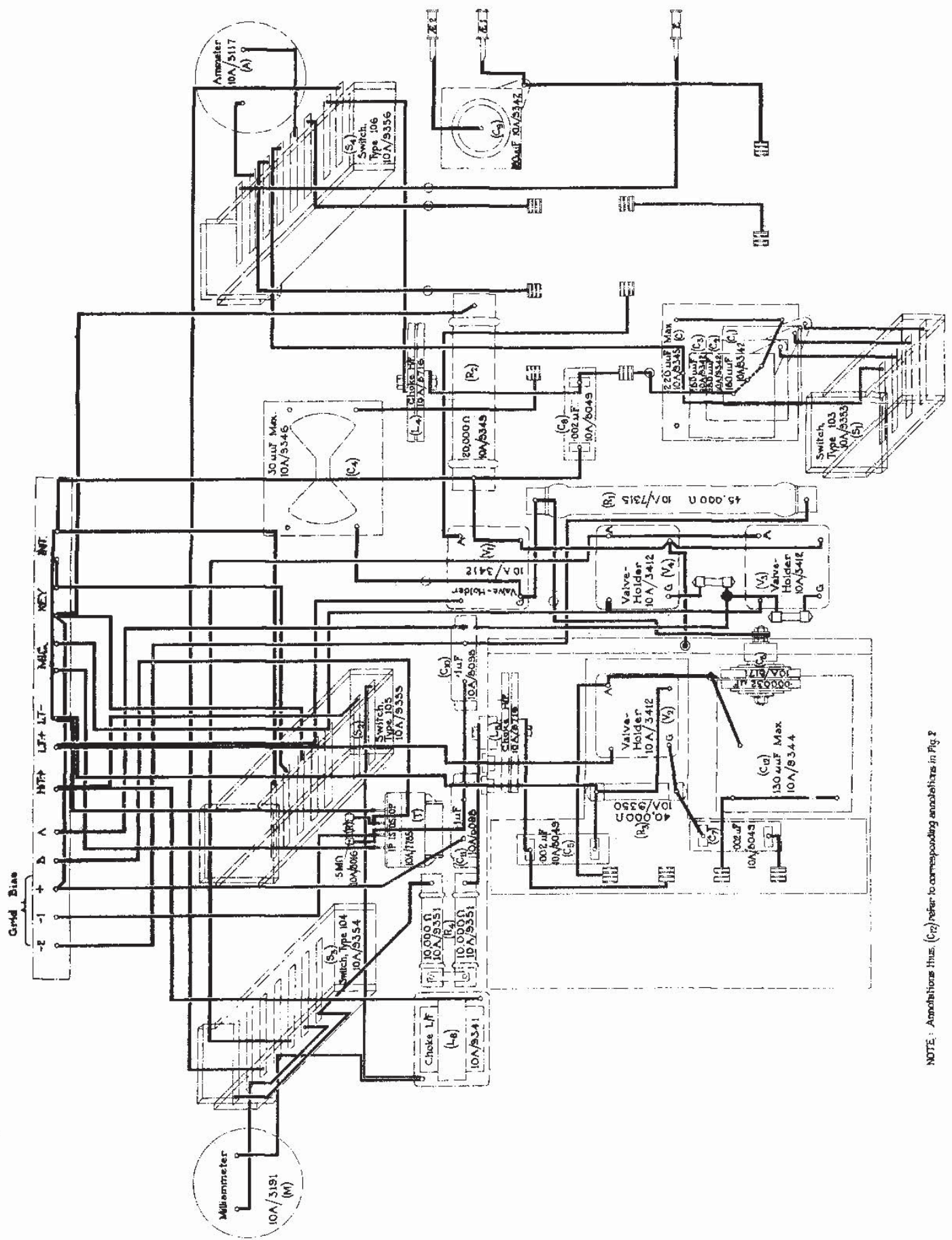


FIG. 9. Theoretical circuit diagram. (Side-tone unit.)

is open the value is 1 megohm. Thus one or other side-tone signal strength may be selected to suit the varying conditions met with owing to change of frequency and power. For R/T or I.C.W., side-tone signals will be obtained in the telephones whenever the microphone is spoken

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NOTE: Annotations H115, (C12) refer to corresponding annotations in Fig. 2

Facing paras. 29-33.

FIG.10, BENCH WIRING DIAGRAM, T.1090

into or the transmitter keyed. For C.W., however (no modulation), unless provision is made, there will be no response. The method adopted to obtain a side-tone for C.W. is to switch an interrupter into the side-tone circuit. The interrupter of the transmitter, not being required during C.W. transmission, is utilized for this purpose and a switching arrangement is provided to enable it to be switched from the transmitter to the side-tone unit and *vice versa*.

29. The switching arrangement can be seen in the diagram (fig. 9). Switches S_1 and S_2 are operated simultaneously by the movement of a single handle moving between two positions engraved C.W. and I.C.W. and R/T. In the diagram the switch is in the C.W. position. It will be seen that S_1 is open and S_2 is in the position which brings the interrupter on the generator in series with the rectifier and telephones. When the switch is placed in the I.C.W. and R/T position, S_1 is closed, completing a side-tone circuit which consists of the telephones, the resistances R and R_1 and the rectifier. The switch S_2 is now in the position in which it connects the interrupter back into the transmitter circuit. It will be observed that I.C.W. cannot be transmitted until the switch on the side-tone unit has been returned to its correct position (*i.e.*, with the interrupter in the transmitter circuit).

CONSTRUCTIONAL DETAILS

Transmitter

30. Four views of the transmitter are given in figs. 1, 11, 12, 13, and a bench wiring diagram in fig. 10. Referring to fig. 1 which is a view of the transmitter with a set of range A coils in position, the anode current milliammeter (1) is in the top right-hand corner, and adjacent to it the selector switch (2). This switch is engraved M/O, MOD and AMP and when the handle is placed in any of the three positions, the anode current of the appropriate valve will be indicated on (1). Next to the switch (2) is the selector switch (3) which determines the type of radiation. Either C.W., I.C.W., or R/T may be used depending on the position of the switch which is suitably engraved.

31. Below the milliammeter (1) can be seen the master-oscillator tuning coil (4). This coil is for the range A (6,667 to 4,286 kc/s). Next to the coil is the master-oscillator tuning control (5). Movement of this control operates the variable condenser C_{12} , fig. 2. Near the control is a small window indicating the amount of movement of the condenser vanes, a scale graduated in degrees from 0° to 180° being secured to the moving vanes. The hinged valve cover can be seen in the centre of the panel, and access to any of the valves is obtained by undoing the screw (6) and raising the cover. It is suitably perforated for ventilation.

32. To the left of the valve-cover are the components associated with the amplifier valve and the aerial and in the bottom right-hand corner can be seen the amplifier condenser switch (7). This switch has four positions A, B, C and D, and serves to introduce one or more small condensers in the amplifier circuit. Above the switch (7) can be seen the amplifier tuning control knob (8). It is provided with an indicating disc which is visible through a small window. The disc is engraved in degrees from 0° to 180° and is secured to the moving vanes of the condenser C in fig. 2. In the bottom left-hand corner is the range A aerial tuning coil (9) and above it the amplifier tuning coil (10) for the same range. In the top left-hand corner is mounted the aerial ammeter (11), and adjacent to it, the switch (12). This switch has two positions engraved AERIAL TUNING AND TRANSMIT, and AMPLIFIER TUNING AND NEUTRALIZE. To the right of this switch lies the neutralizing condenser control knob (13). The whole instrument is mounted on four anti-vibration mountings, two of which (14) can be seen in the illustration.

33. In fig. 11, which is an interior view of the transmitter, the anode milliammeter (1) is seen in the bottom right-hand corner, and above it the A/F choke (2) which is represented by L_6 in the theoretical circuit diagram, fig. 2. The two resistances (3) above the choke, each have a value of 10,000 ohms and are connected in series in the anode circuit of the M/O valve. The

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contact bar (4) is provided with 14 sockets suitably engraved. The leads from the various batteries, key, microphone and interrupter, terminate in plugs which engage with these sockets. Below the contact bar can be seen the microphone transformer (5). Below the transformer is the selector switch (6). This switch enables the anode current of any valve to be read on the milliammeter (1). To the left of this switch is the selector switch (7) which determines the type of radiation, for example, C.W., I.C.W., or R/T.

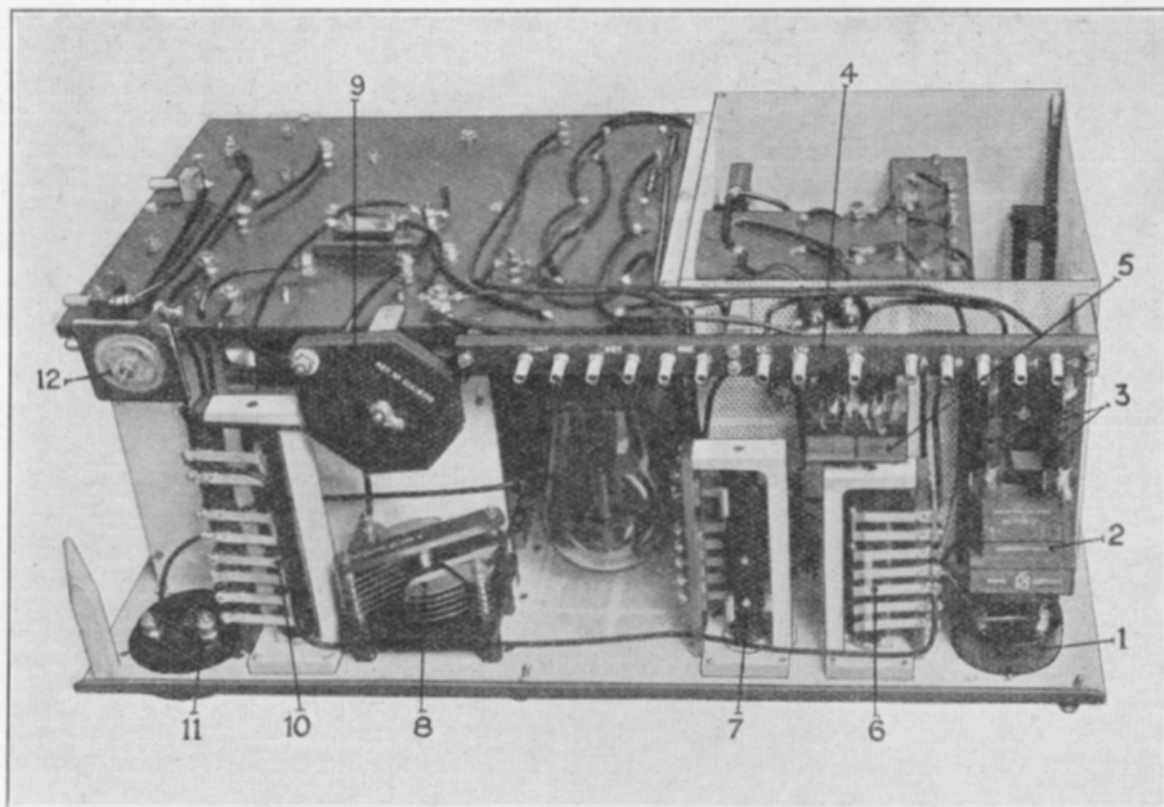


FIG. 11. Interior view.

34. The valve seen in the centre of the illustration is the amplifier valve. The two modulator valves are behind the amplifier. The condenser (8) seen in the foreground is the neutralizing condenser. The R/F choke (9) above the neutralizing condenser is represented by L_4 in the theoretical circuit diagram fig. 2. The transmit-neutralize switch (10) can be seen to the left of the neutralizing condenser while the aerial ammeter (11) is in the bottom left-hand corner. The condenser (12) in the top left-hand corner has a value of $\cdot 00018\mu\text{F}$ and is the aerial condenser C_9 , fig. 2.

35. An underside view of the transmitter is given in fig. 12. The aerial and earth plugs (1) and (2) respectively are seen on the right, the $\cdot 002\mu\text{F}$ condenser (3) being the mains condenser C_8 , fig. 2. The components on the left of the illustration are associated with the M/O valve. In the centre is seen the base of the valve-holder (4), while immediately below it lies the M/O tuning condenser (5). To the right is another condenser (6). It has a value of $\cdot 00032\mu\text{F}$ and is the coupling condenser between the M/O and amplifier valves. The condenser (7) has a value of $\cdot 002\mu\text{F}$ and is connected between the inductance and grid of the M/O valve. The $\cdot 002\mu\text{F}$ condenser (8) to the left of the valve-holder is the mains condenser C_5 in the theoretical circuit diagram, fig. 2.

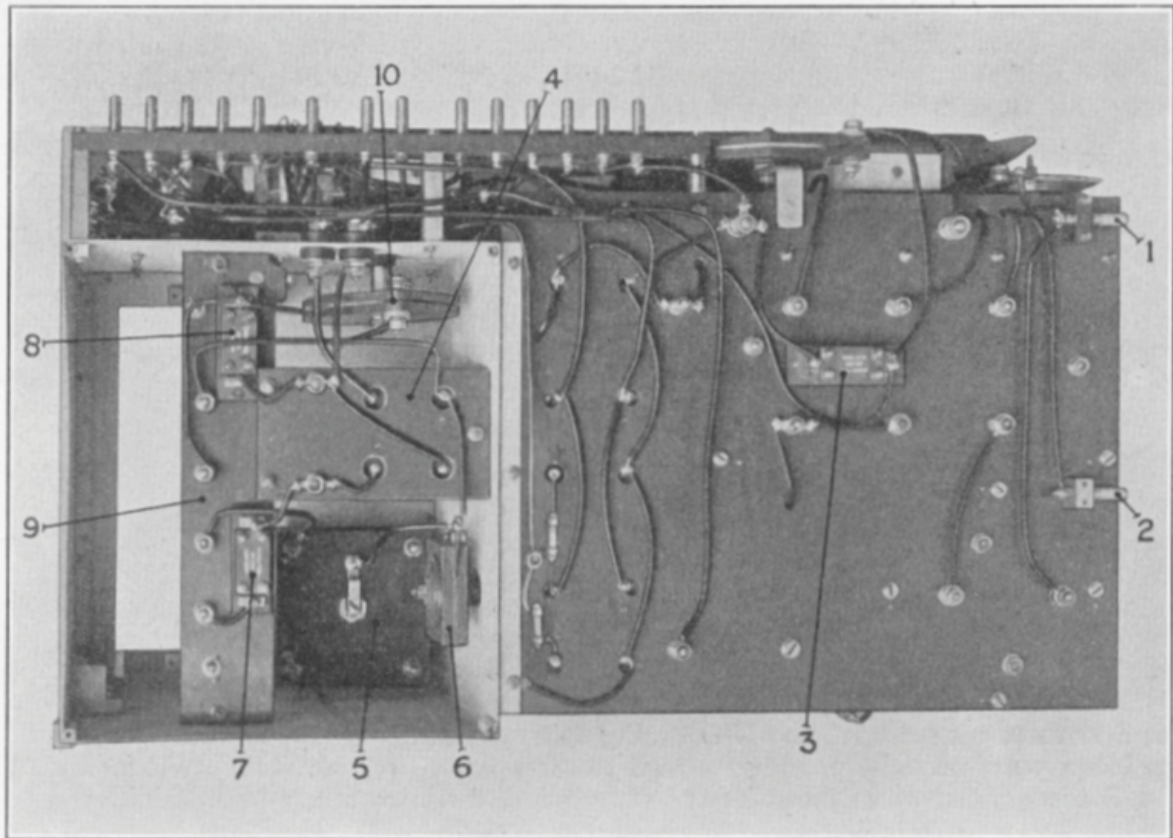


FIG. 12. Underside view.

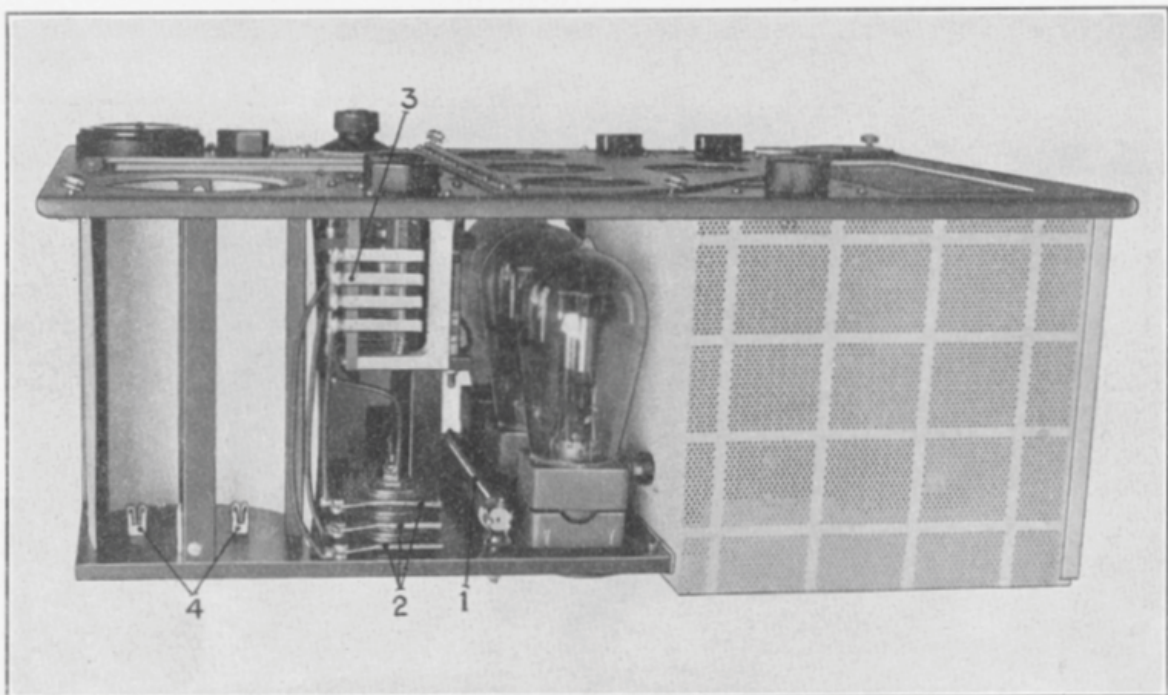


FIG. 13. Side view.

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36. The base (9) of the master-oscillator tuning coil forms the support for the two condensers (7) and (8). The R/F choke (10) seen to the right of the coil-holder is connected in the anode circuit of the M/O valve and is represented by L_3 in fig. 2. The contact bar seen at the top of the figure has been referred to previously (see 4, fig. 11).

37. Referring to fig. 13, which is a side view of the transmitter, it will be seen that the master-oscillator chamber is entirely screened, perforated metal being employed for ventilation. Of the three valves seen in the foreground, the first two are the modulators and the rear one is the amplifier. The resistance (1) seen near the valves is the grid-leak resistance R_1 in fig. 2 and has a value of 45,000 ohms. The three condensers (2) each have a value of $.00018\mu\text{F}$. They are represented by C_1 , C_2 and C_3 in fig. 2, and may be included in the amplifier circuit by operating the switch (3) immediately above them. The space on the left-hand side of the transmitter is normally occupied by the aerial tuning coil. The two contacts (4) on the base of the coil-holder are clearly visible.

Coils

38. The frequency bands of the transmitter are covered by sets of plug-in coils. One set of three coils is provided for each of the ranges A, D and E, while ranges B and C have a common aerial coil engraved accordingly. Each set of coils consists of an aerial tuning coil, an amplifier tuning coil and a master-oscillator tuning coil. The set for range C is shown in fig. 14. The aerial coil for the range A and the coil provided for B and C have a similar general appearance, while the aerial coils for the ranges D and E are similar to each other but differ slightly from those of the first three ranges. All the M/O tuning coils are similar in appearance except for range C which has a switch handle passing through the top plate. The amplifier coils for the ranges B, D and E are similar, while those for the ranges A and C have a switch in addition.

39. The amplifier coils for all five ranges are similar in appearance and are built up on rectangular formers of composite insulating material. The top of each coil is provided with an aluminium alloy plate, and two screws pass through the plate and secure the coil in position. The various tapping points are brought out to six knife contacts secured to the base. The inductance is varied by means of a variometer built into the coil. A knob is provided on the top plate by which the variometer may be controlled. On the ranges A and C, in addition to the

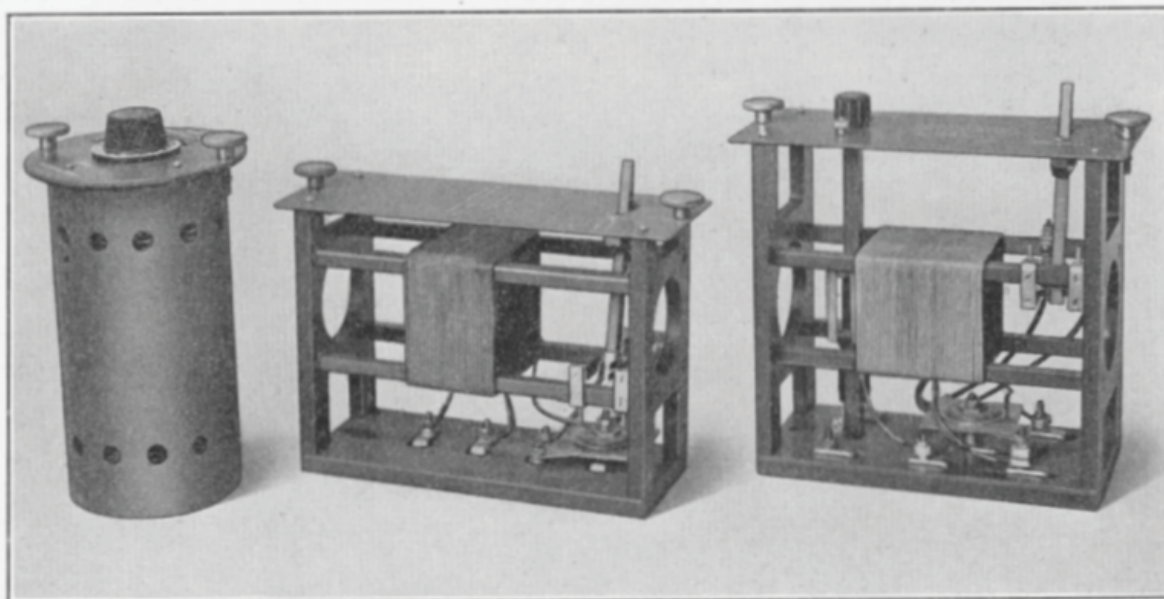


FIG. 14. Aerial, Master-oscillator, and Amplifier coils (Range C).

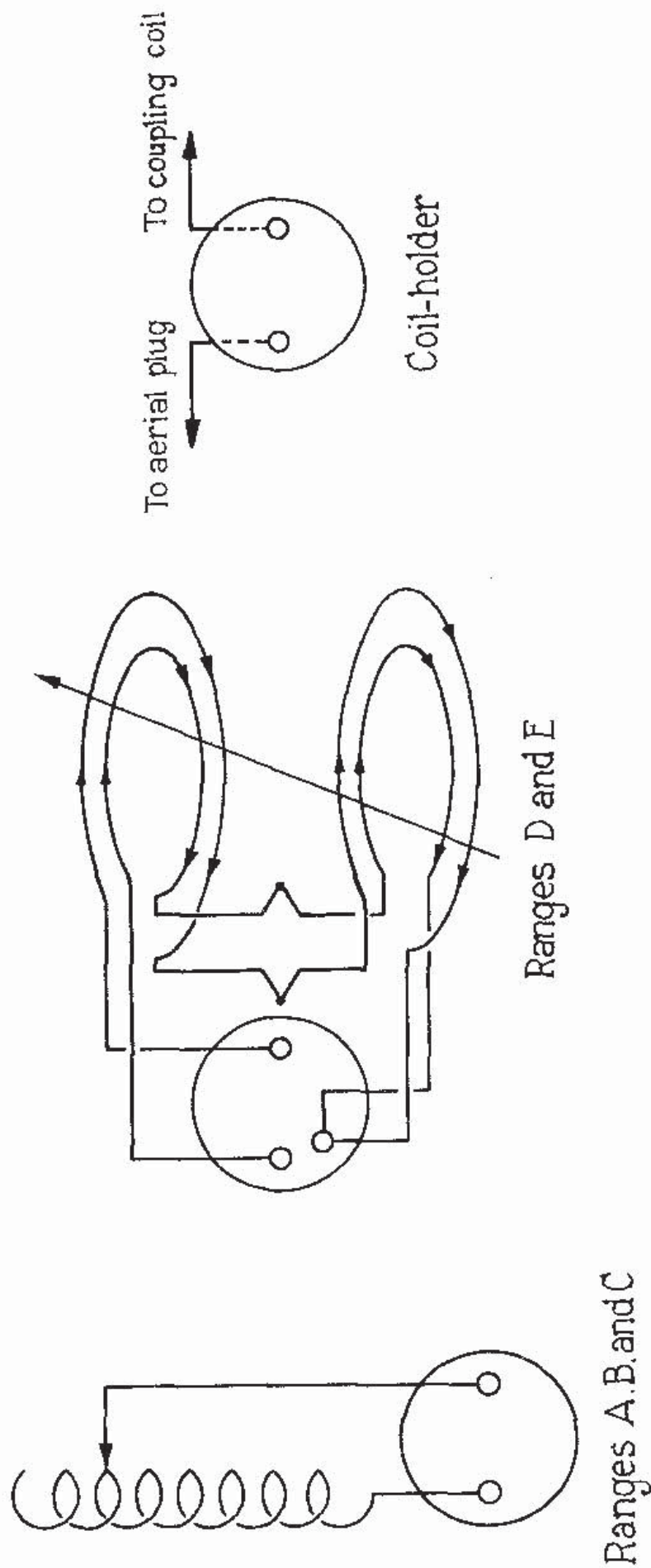


FIG.15, COIL DIAGRAMS (AERIAL)

variometer, a switch is provided which splits up the frequency band covered by the coil. Thus in the case of the amplifier coil range A (6,667 to 4,286 kc/s), the switch divides this band into two frequencies: 6,667 to 5,455 kc/s and 5,455 to 4,286 kc/s. In the case of the coil range C (3,409 to 2,000 kc/s), the switch divides this band into two frequencies 3,409 to 2,500 kc/s and 2,500 to 2,000 kc/s.

40. All the master-oscillator coils are similar in appearance, the range C coil only being provided with a switch. The constructional features are the same as those of the amplifier coils, except that the M/O coils are somewhat smaller and only four knife contacts are provided in the base.

41. The aerial tuning coils differ from the M/O and amplifier coils in that they are cylindrical coils. The windings and coil former are encased in a shield of insulating material. The top of the coil is formed from composite insulating material and the base is provided with two knife contacts. The range A coil and coil for range B and C are each provided with a central control knob by means of which the inductance of the coil may be varied. An indicating window shows the amount of movement of the variable tap. The coils for the ranges D and E differ from the others in that the control knob instead of being central, is disposed somewhat near the edge of the top plate. Furthermore instead of the inductance being tapped, as in the case of the coils A, or B and C, the variometer principle is employed.

42. The aerial tuning coils for the ranges A, B and C (see fig. 15) are wound with $\frac{1}{8}$ in. dia. 22 s.w.g. plated copper tube. A rotatable brush makes contact with the inside of the coil, the number of turns being recorded on an indicating device at the top of the coil. In addition to the coil of copper tubing, the coil for range B and C has a winding of 5 turns of 16 s.w.g. double-covered copper wire in series with the main winding. The finish of the winding is brought to one contact on the coil base and the variable tap to the other contact. The main winding for coil A range (6,667 to 4,286 kc/s) has $18\frac{1}{2}$ turns, while the main winding for the B and C range coil (4,615 to 2,000 kc/s) has $30\frac{1}{2}$ turns.

43. The aerial coils range D and E (2,069 to 1,222 kc/s) and (857 to 545 kc/s) respectively consist of a rotor and a stator. Each winding employs 27/39 single silk-covered stranded copper wire, double silk-covered overall. Each coil is provided with two knife contacts secured in the base to which the windings are connected. The rotor and stator of the range D coil have 14 turns each (7 per slot). The rotor of range E coil has 50 turns (25 per slot) and the stator has 38 turns (19 per slot).

44. The amplifier tuning coil range A (6,667 to 4,286 kc/s) is provided with two windings, one stator and one rotor. The rotor is wound with 6 turns of 27/39 stranded copper wire, each strand is single silk-covered and all the strands are double silk-covered. The stator is wound in three sections. The first section has $6\frac{3}{4}$ turns of 20 s.w.g. double cotton-covered copper wire. The second section is wound with $3\frac{3}{4}$ turns of 81/40 stranded copper wire enamelled and braided cotton-covered. The third section is wound with $6\frac{1}{4}$ turns of 20 s.w.g. double cotton-covered copper wire. The rotor is connected across the first two contacts. Various tappings are taken from the stator as follows; section one, 2 turns from the start, section two at $\frac{3}{4}$ turns from the start. Section three is connected across the last two contacts on the coil base. A diagram of connections is given in fig. 16.

45. The amplifier coil range B (4,615 to 3,000 kc/s) is provided with a rotor and a stator. The rotor is wound with 6 turns of 27/39 single silk-covered stranded copper wire, double silk-covered overall. The winding is connected across the first two contacts on the coil base. The stator is wound in two sections, the first section has 17 turns of 81/40 stranded enamelled copper wire braided-cotton-covered. The second section has $9\frac{1}{4}$ turns of 20 s.w.g. double cotton-covered copper wire. A tapping is taken at $12\frac{1}{4}$ turns from the start of the first section. This tapping and the start of the winding are connected across the second pair of contacts on the coil base.

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The end of the first section and the start of the second section are connected together and joined to one of the last pair of contacts, while the end of the second section is joined to the other contact of the last pair (see fig. 16).

46. The amplifier coil range C (3,409 to 2,000 kc/s) is provided with a rotor and a stator. The rotor is wound with 8 turns of 27/39 single silk-covered stranded copper wire, double silk-covered overall. The winding is connected across the first pair of contacts on the coil base. The stator is wound with 33 turns of 81/40 stranded enamel copper wire, braided-cotton-covered. Tappings are taken at $15\frac{1}{4}$ and 21 turns from the start. The start of the winding and the first tap are connected across the second pair of contacts, and the second tap and end of the winding are connected across the third pair of contacts. A $.0004\mu\text{F}$ condenser is connected in series with a switch between the tapping points on the coil (see fig. 16).

47. The rotor winding on the amplifier coil range D (2,069 to 1,222 kc/s) is wound with 11 turns of 27/39 single silk-covered stranded copper wire, double silk-covered overall, and connected across the first pair of contacts on the coil base. The stator is wound with $51\frac{1}{4}$ turns of 81/40 stranded enamel braided-cotton-covered copper wire; tappings are taken off at $12\frac{1}{4}$ and 26 turns from the start. The start of the winding and the first tap are connected across the second pair of contacts, while the second tap and end of the winding are connected across the third pair of contacts (see fig. 16).

48. The rotor of the amplifier coil range E (827 to 545 kc/s) is wound with 27/39 single silk-covered copper wire, double silk-covered overall. The winding is connected across the first pair of contacts on the coil base. The stator is divided into three sections and connected up as shown in fig. 16. The first section is wound with $35\frac{1}{4}$ turns of 24 s.w.g. double cotton-covered copper wire. The second section is wound with $31\frac{3}{4}$ turns of 18 s.w.g. double cotton-covered copper wire, and the third section is wound with $50\frac{1}{4}$ turns of 24 s.w.g. double-cotton-covered copper wire.

49. The M/O tuning coil range A (6,667 to 4,286 kc/s) has one winding wound with 11 turns of 81/40 stranded enamelled copper wire, braided-cotton-covered, tapped at the third turn from the start. The first and second contacts on the coil base are short-circuited. The start of the winding is connected to the second contact, the tapped portion to the third contact and the finish of the coil to the last contact. A diagram of connections is given in fig. 17.

50. The M/O coil for range B (4,615 to 3,000 kc/s) and the coil for range D (2,069 to 1,222 kc/s) have the same circuit diagram, as can be seen in fig. 17, but the windings of each coil are different. The coil for range B is wound with 17 turns of 81/40 stranded enamelled braided-cotton-covered copper wire, and tapped at six turns from the start. The coil for range D is wound with 36 turns of 18 s.w.g. double cotton-covered copper wire, tapped at 11 turns from the start.

51. The M/O coil for range C (3,409 to 2,000 kc/s) is wound with 23 turns of 14 s.w.g. double cotton-covered wire tapped at seven turns from the start. The start of the winding is connected to the first knife contact on the coil base, the tap is connected to the third contact, and the finish of the coil is connected to the fourth contact. Between the first and second contacts, a $.00018\mu\text{F}$ condenser is connected. A switch incorporated in the coil is capable of short-circuiting this condenser if required (see fig. 17).

52. The M/O coil for range E (857 to 545 kc/s) is wound with 126 turns of 18 s.w.g. double-cotton-covered copper wire, tapped at 56 turns. The start of the winding is connected to the first contact on the coil base. The tap is connected to the third contact, and the end of the winding is connected to the last contact. The first and second contacts are short-circuited. Two $.00018\mu\text{F}$ condensers are connected in series across the first and fourth contacts (see fig. 17).

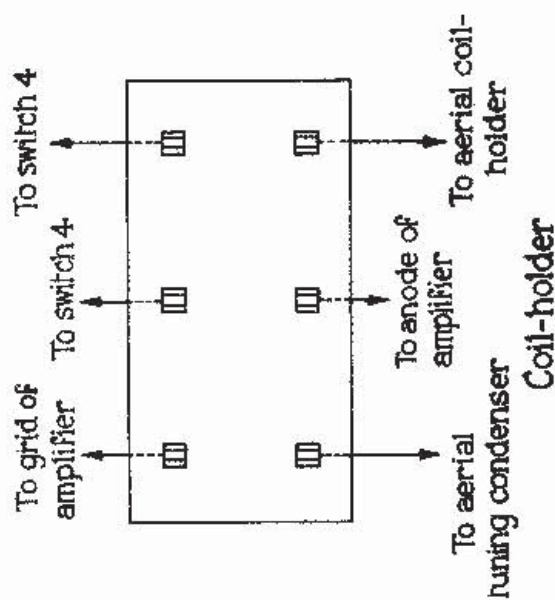
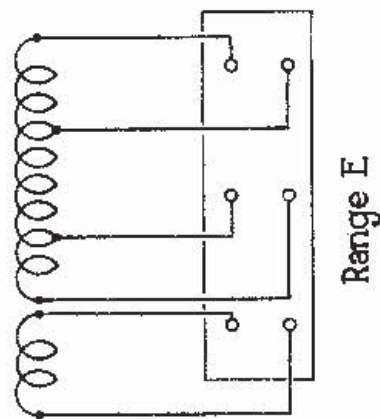
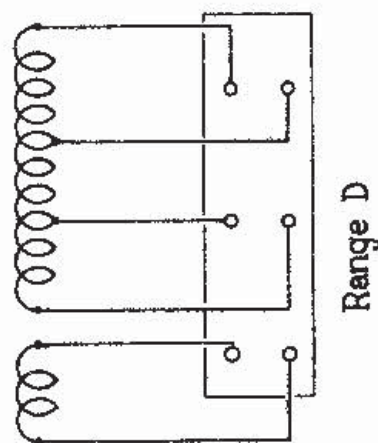
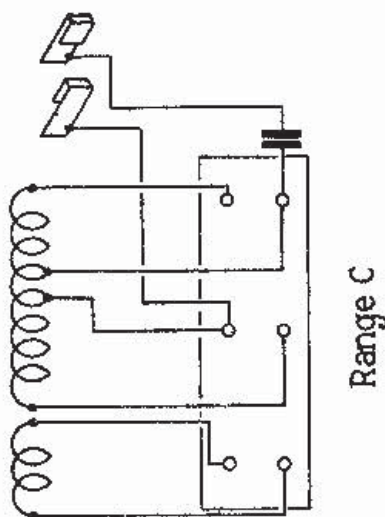
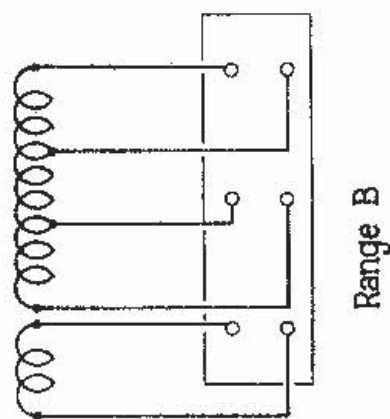
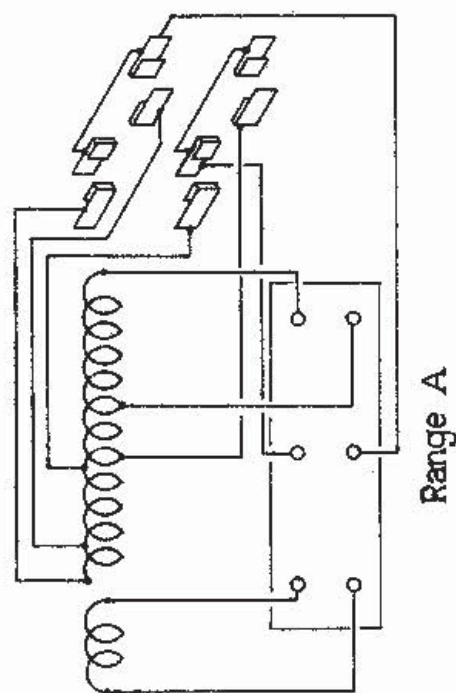


FIG. 16. COIL DIAGRAMS (AMPLIFIER)

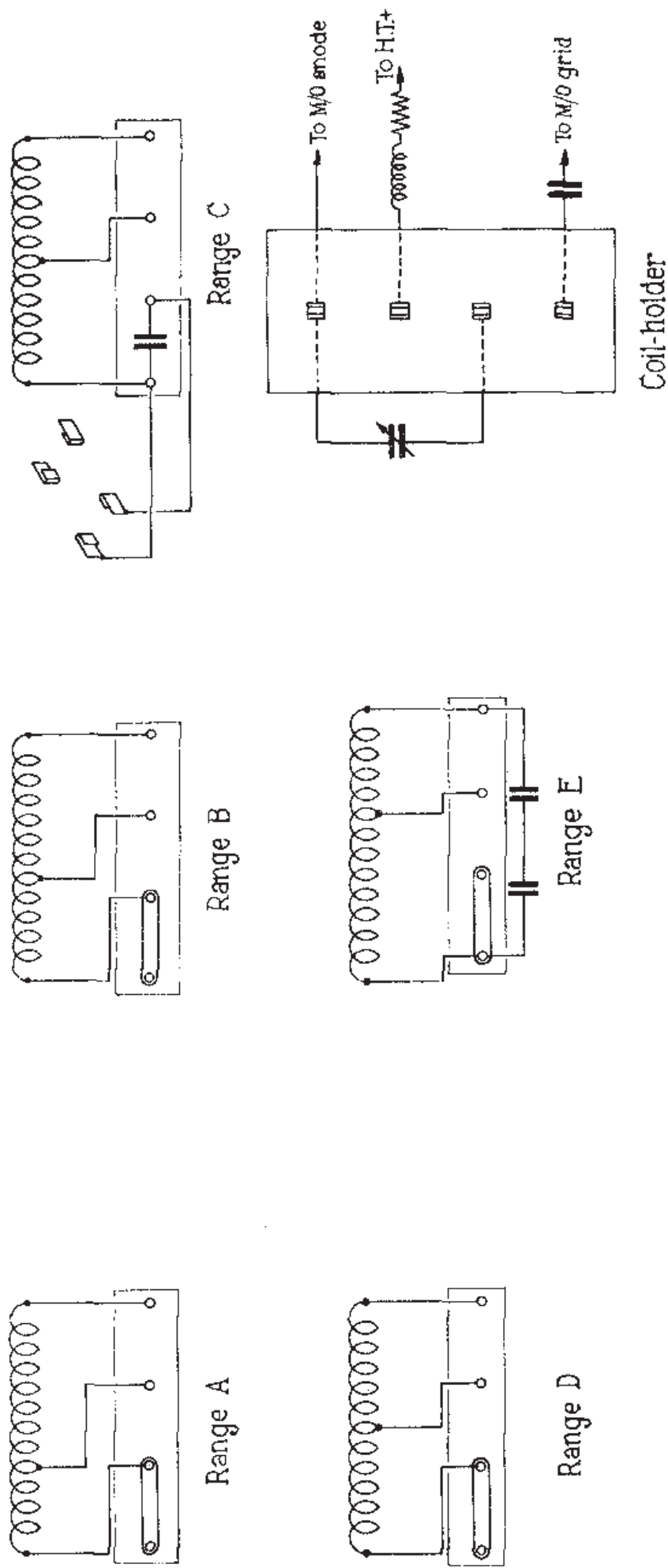


FIG.17. COIL DIAGRAMS (MASTER-OSCILLATOR)

Automatic grid-bias unit

53. The automatic grid-bias unit is shown in fig. 18. It consists of an aluminium case (1) approximately 8 in. $\times$ 6 in. $\times$ 4 in., inside which are mounted two wire wound potentiometers (see fig. 8). The potentiometers incorporate toroidal wound resistances on cylindrical formers with self-lubricating copper-graphite contacts operated by handles, each element having a resistance of 3,500 ohms. The case has been designed with the object of making the unit both sand and moisture proof, special sealing means being provided for the operating spindles of the potentiometers. Since the air enclosed within the case is liable to contract and expand under the influence of temperature change, a pressure stabilizing device has been provided in the base. This consists of a chrome-leather diaphragm which will readily expand with increased pressure. The diaphragm is covered by a fine mesh screen for protection.

54. Three of the four plugs on the right of the instrument are engraved GB-2, GB-1 and GB+ respectively. The plugs GB-2 and GB-1 are connected to the movable contacts on the amplifier and modulator resistance element respectively. The plug GB+ is connected to the start of both resistances and the un-engraved plug is connected to the finish of both resistances (see fig. 8). The plugs are similar to those on the grid-bias battery box described elsewhere. The two units are interchangeable.

55. The front of the case is provided with two operating handles (2) and two scales engraved from 0-100. The one on the left is for the amplifier valve and the one on the right for the modulator valves. An indicating line is engraved on each handle to facilitate setting and reading. The scales are suitably engraved with an arrow to indicate in which direction the handles should be rotated to increase the bias.

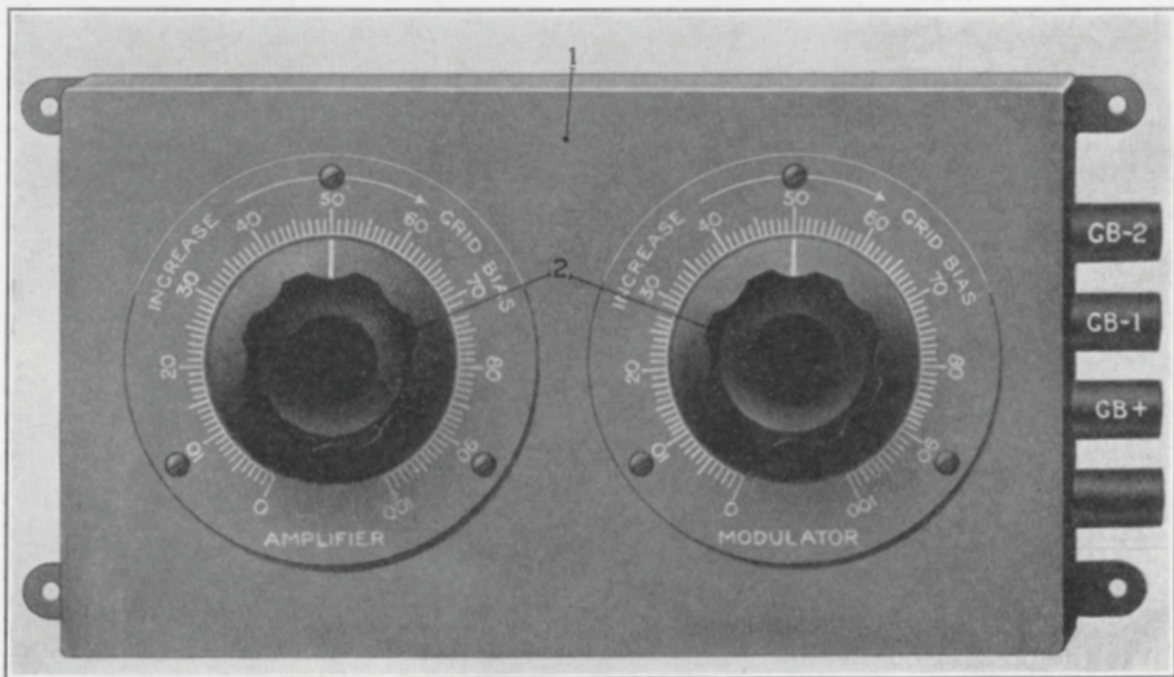


FIG. 18. Automatic grid-bias unit.

Grid-bias battery and box

56. As an alternative to the automatic grid-bias unit, the necessary bias for the valves may be obtained from a battery. This unit which is illustrated in fig. 19 consists of twelve 15-volt units contained in a wooden case. The case (1) is built up of teak and painted inside with an anti-corrosive paint. The lid is retained in the closed position by means of the two spring catches (2).

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Along one side of the case is a fixed strip of wood (3). This strip is arranged so that its lower edge is just high enough to allow the batteries to pass under it. Along the opposite side is a movable piece of wood (4). As can be seen in the illustration this strip is longer than the total width of all the batteries and is equal in depth to the box. If it is necessary to remove one or more of the 15-volt units, the screw (5) is slackened back allowing the strip (4) to move towards the side of the case. The defective unit can then be moved so as to be free of the fixed strip (3) and removed from the case. After replacement the screw (5) is tightened up again. Eleven battery connectors (6) are provided. Each connector consists of a piece of flexible insulated wire terminating at each end in a spring plug. The 15-volt units are arranged so that the + and - ends are adjacent to each other and the plugs are inserted in position.

57. A terminal strip (7) having four sockets is provided at the left of the case. As can be seen, three of these sockets are engraved -2, -1 and +. The last two sockets are short-circuited by a link (8). Four plugs engage these sockets externally. The plugs are the same as those used on the automatic grid-bias unit (see fig. 18). The socket engraved + is connected by a flexible

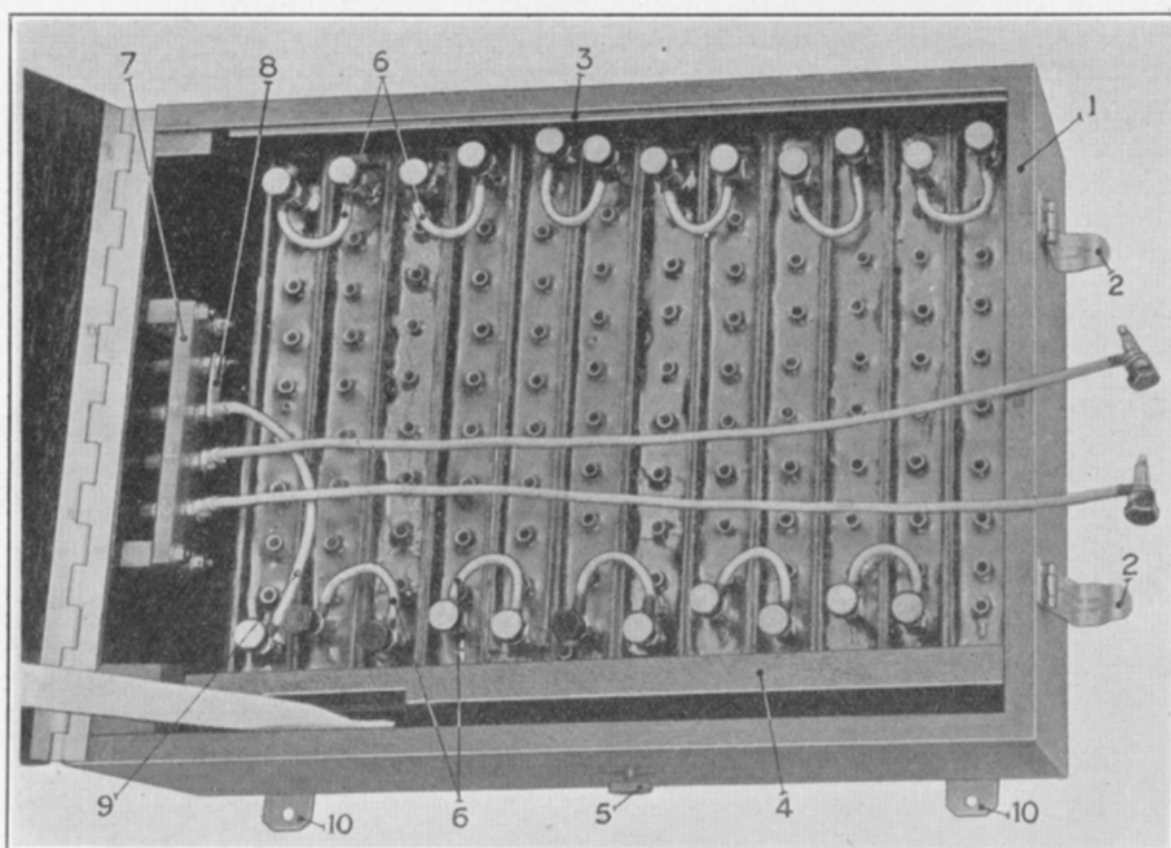


FIG. 19. Grid-bias battery unit.

lead (9) to the positive contact of the first 15-volt unit. The sockets engraved -2 and -1 are each provided with a flexible lead terminating in a spring plug and long enough to engage any of the sockets of the last 15-volt unit. It is thus possible to obtain a bias up to 180 volts between the socket engraved + and either of the two sockets engraved -1 or -2. Four securing lugs are provided on the base of the case, two of which (10) can be seen in the foreground.

Side-tone unit

58. An illustration of the side-tone unit is given in fig. 20. It consists of a metal case (1) in which are housed three condensers, a metal rectifier and two resistances. On the front panel

of the case are mounted two telephone jacks (2) and two switches (3). The two jacks are wired in parallel, the one on the right for the receiver output and the one on the left for the telephones. The switch handle on the left simultaneously operates a D.P.D.T. switch and an "on and off" switch. The former changes over the connections of the interrupter, allowing it to interrupt the side-tone circuit or the transmitter circuit. The "on and off"

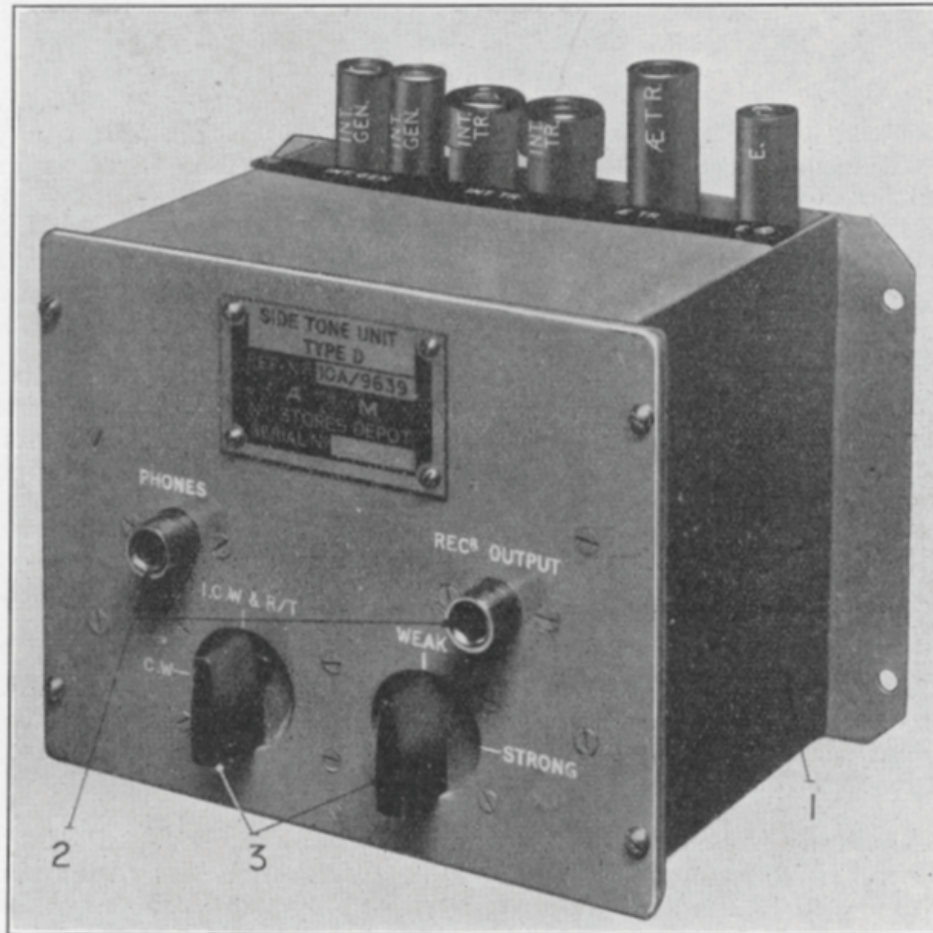


FIG. 20. Side-tone Unit. Type D.

switch completes the side-tone circuit when the interrupter is removed. The right-hand switch which is marked WEAK and STRONG, short-circuits, in the "strong" position, one of the series resistances. The six plugs at the rear of the side-tone unit are engraved INT. INT. INT. INT. AE.TR. and E. Flexible connections are taken from these plugs to the interrupter terminals on the generator, the interrupter terminals on the transmitter, and the aerial and earth terminals respectively. The circuit diagram of the unit is given in fig. 9.

VALVES, GENERATORS AND BATTERIES

59. Four type V.T.25 valves are used, one as a master-oscillator, one as an amplifier and two in parallel, as modulators. The L.T. supply is obtained from accumulators. In a tender, alkaline accumulators will normally be used, and the requisite number of cells to provide 8-volts will be required. The H.T. is obtained from either an 80-watt motor-generator, type E, or a 255-watt motor-generator. The 80-watt M/G is driven from a 14-volt battery and the 255-watt M/G is driven from a 24-volt battery.

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60. The transmitter is capable of dealing with input power of about 200 watts. If, in order to obtain a larger output, it is necessary to overload the 80-watt generator, suitable ventilation must be arranged and prolonged runs must be avoided. When using the 80-watt M/G the automatic grid-bias unit is not employed. Grid bias is then obtained from a 180-volt battery consisting of twelve 15-volt units contained in a wooden box with the necessary plug-in connections.

OPERATION

61. The following paragraphs describe the way in which the transmitter may be adjusted for operation. When making these adjustments reference should be made to Tables 1 to 7. Before commencing to use the transmitter, make sure that all external leads are correctly connected. Particularly, see that there is a connection from the negative terminal of the L.T. battery to earth. The appropriate coils should now be plugged in and the modulator bias (G.B.—1) set to the maximum bias position. The amplifier valve grid-bias (G.B.—2) is also set initially to maximum.

62. Set the selector switch to R/T, the anode current milliammeter switch to MOD and the "Transmitter-neutralize" switch to AMP TUNING AND NEUTRALIZE. Set the aerial coupling coil (on the amplifier tuning coil) to 0, and the master-oscillator tuning to the setting given in the appropriate table nearest the desired frequency, and switch on the L.T. supply.

63. If an H.T. generator provided with a field control is used, adjust the field to give an H.T. voltage of 1,000 volts. Since no such control is normally available on the 80-watt generator, the voltage will be of the order of 1,200 volts. Switch on the H.T. and read the anode current taken by the modulator valves. A small current reading should be obtained by adjusting the modulator bias. If, when using the 80-watt motor-generator the anode current is greater than 60 mA some fault is indicated either in the bias arrangement, or in the valves, or in the H.T. supply. Switch off the H.T. and set the milliammeter switch to M/O. On switching on the H.T. again, the M/O current should be about 20 mA. (The anode current varies between 15 and 25 mA dependent on variations of frequency and H.T. supply.)

64. Set the neutralizing condenser to zero and tune the amplifier closed circuit by observing the thermo-ammeter; an optimum reading should be obtained. As the reading in the ammeter increases, the value of the current should be reduced step by step by means of the neutralizing condenser so that when the amplifier circuit is tuned, the ammeter should indicate a minimum (quarter scale reading or less). This is the correct neutralizing position.

65. Switch off the H.T., put the "Transmit-neutralize" switch to AERIAL TUNING AND TRANSMIT and introduce a little aerial coupling, say 10 degrees, *i.e.* move the aerial coupling knob on the amplifier coil to the position engraved 1. Switch on the H.T., adjust the amplifier bias and tune the aerial circuit, retuning the amplifier and aerial circuits alternately until a maximum aerial current reading is obtained. The amplifier circuit can best be tuned by setting the milliammeter switch to AMP and tuning to a minimum anode current. Increase the aerial coupling by degrees, re-tuning the amplifier and aerial circuits each time, until a maximum aerial current is obtained without the "double hump" tuning effect in the aerial circuit.

66. It will now be necessary to adjust the anode currents in the amplifier and modulator valves. The total power is shared by the three circuits M/O, AMP and MOD. Assuming the generator will give 80 watts at 1,000 volts, there is a current of 80 mA available for these three circuits. If the M/O takes 20 mA, the remaining 60 mA will be shared between the amplifier and modulators roughly in the proportion of 25 mA for the amplifier and 35 mA for the modulators. If a 255-watt M/G is used and the H.T. voltage can be adjusted, the current in the three circuits should be increased proportionally, though the total current should not exceed 150 mA since the modulator choke is rated at 150 mA maximum. If 200 watts is available, a voltage of 1,300

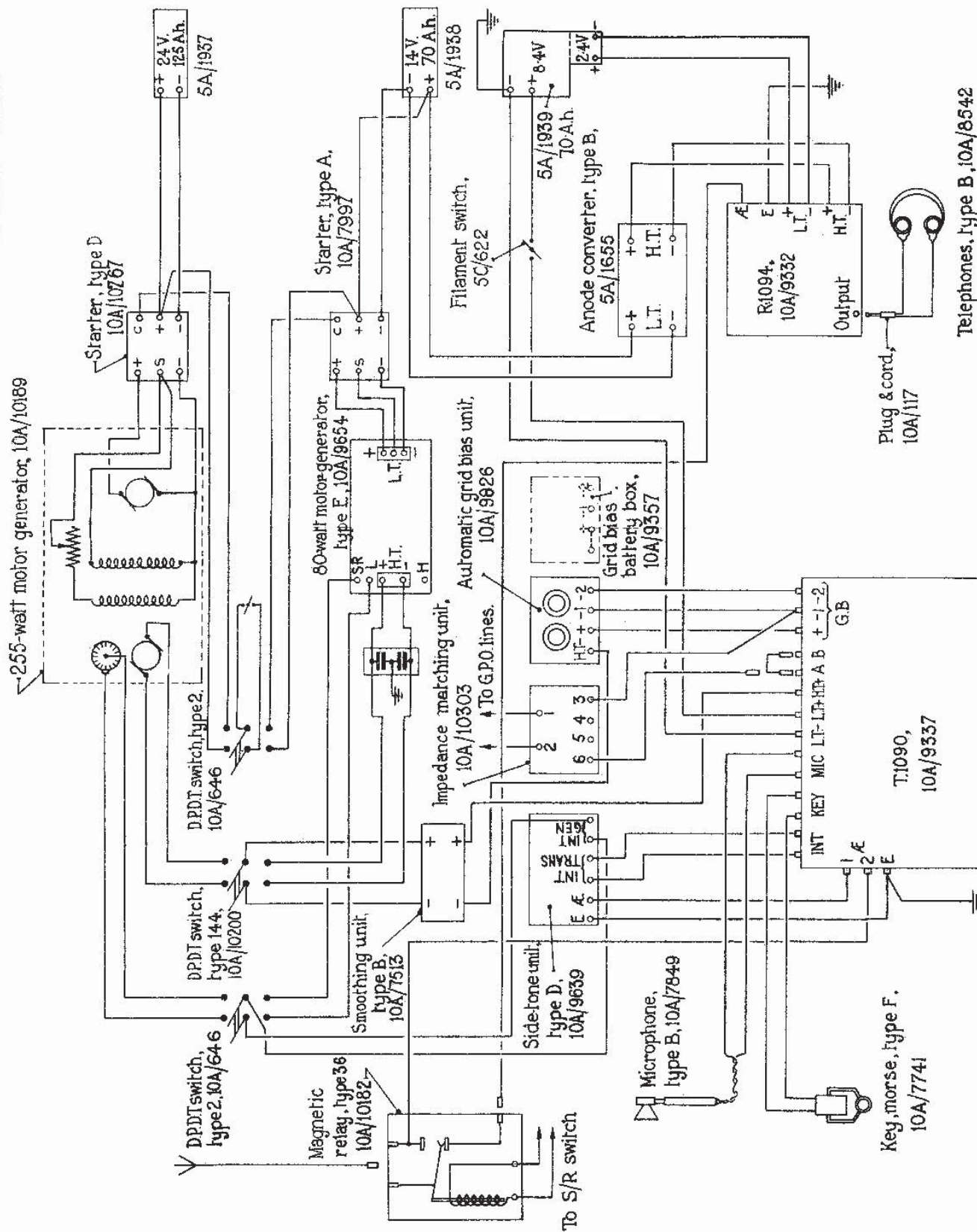


FIG. 21. INSTALLATION DIAGRAM, T.1090

approximately is all that is necessary in order to provide a total current of 150 mA. In these circumstances since 25 to 30 mA are taken by the M/O, 120 to 125 mA must be shared between the amplifier and modulators, a suitable allocation being 50 to 55 mA for the amplifier and mA for the modulator. These values depend upon the H.F. voltage available, but they should be approximately in this ratio. The V.T.25 valves used in the modulator stage have a rated maximum anode dissipation of 60 watts, hence the power used by the two valves should not exceed 120 watts. Using a voltage of 1,300 volts the maximum permissible current in the modulator is 90 mA approximately.

67. Adjust the bias of the amplifier and modulator valves and if necessary adjust the aerial coupling until the anode currents are in the ratios given in the previous paragraph. Check the frequency. Wavemeter W.1081 may be used if the transmitter is being operated on range A or B (6,667 to 3,000 kc/s). Wavemeter W.1095, if available, may be used for Range C (2,000 to 3,409 kc/s) and part of range D. On the other frequencies a wavemeter W.39 may be used. If the frequency is incorrect determine the M/O setting to give the required frequency by interpolation from the table (see para. 76) and after having set up the M/O, tune the amplifier and aerial circuits.

68. Check the depth of modulation by means of a Modulation Indicator, type 1 (Stores Ref. 10A/8219) if available. Using the handpress microphone (Stores Ref. 10A/7849) provided for local working, a loud "Hullo" spoken into the microphone should give 75 per cent. modulation. Where the modulation indicator is not available, some idea of the modulation may be gained by observing the rise in aerial current with modulation. A rise of 15 to 20 per cent. should be obtainable by shouting. Check the speech quality by using either the modulation indicator or by listening on the side-tone unit; separate individuals should do the speaking and listening. The percentage modulation and quality of speech may be varied by adjustment of the grid-bias of the modulator valves.

69. For C.W. or I.C.W. operation it is only necessary to set the selector switch and the side-tone switch to the appropriate positions. It should be observed that, owing to the removal of the modulator valve load from the generator, the values of anode and aerial current are higher for C.W. than for R.T. If, when operating on the 857 to 545 kc/s band an increase in working range is desired, this can be obtained by using a 150-ft. single wire aerial on 30-ft. masts with earth mats.

Adjustment of transmitter for various frequencies

3,800 to 6,940 kc/s

70. Assume it is desired to set the transmitter to a frequency of 5,000 kc/s. The coils required are the range A coils and the table of reference is Table 1. By interpolation from the table it will be seen that the desired frequency can be obtained with the amplifier coil switch at position 1 or 2. Position 1 is selected as being more appropriate. The frequency required falls between 5,295 and 4,795, and roughly half way. Set the M/O tuning to 75 as a first approximation. Tuning up the transmitter and checking on a wavemeter W.1081, the radiated frequency is found to be 5,033 kc/s or 33 kc/s too high. It will be seen that the difference in frequency is 5,295 - 4,795 or 500 kc/s, and the difference in the M/O setting for these frequencies is 90 - 60 or 30 scale divisions. In this region of the scale therefore one division is equal to $\frac{500}{30}$ or 16.6 kc/s. The M/O is therefore increased two divisions or 33.2 kc/s (16.6 + 16.6) and the transmitter re-tuned when the radiated frequency will be found to be 5,000 kc/s.

1,970 to 3,500 kc/s

71. Assume it is desired to set the transmitter to 3,000 kc/s. Coils required, range C. table of reference, Table 3. The required frequency falls between 3,130 and 2,850 kc/s, and is again roughly half way between them. Set the M/O tuning at 45, with the coil range switch in

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position 2. On tuning the transmitter, the radiated frequency, measured by the wavemeter, is found to be 2,950 kc/s or 50 kc/s low. At this position of the tuning scale 280 kc/s (3,130—2,850) is equivalent to 30 (90—60) scale divisions, or each scale division equals $\frac{280}{30}$, or 9.3 kc/s. It is, therefore, necessary to set the master-oscillator tuning $\frac{50}{9.3}$ or 5.4 scale divisions lower than 45, *i.e.*, to 39.6, say 40. Setting-up to this value and re-tuning, the frequency is found to be 3,000 kc/s ± 2 kc/s.

1,207 to 2,120 kc/s

72. The desired frequency is 1,250 kc/s. The coils required are range D, and the table of reference is Table 4. The required frequency in this case is only 34 kc/s different from 1,284. The difference between 1,284 and 1,207 is 77 kc/s. This difference corresponds to a difference of 180—150 or 30 scale divisions, which is roughly 2.5 kc/s per scale division. Now 34 kc/s correspond to 13 scale divisions, so as a first approximation set the M/O tuning to 150 + 13 or 163 scale divisions. On tuning the transmitter, the radiated frequency, as measured by the wavemeter, is found to be 1,240 kc/s and this is 10 kc/s low, so that the proper M/O setting should be $\frac{10}{2.5}$ or 4 divisions less, *i.e.* 159. On re-setting the M/O to this value and tuning the transmitter the radiated frequency is found to be 1,250 kc/s.

INSTALLATION

73. Fig. 21 is an installation diagram of transmitter T.1090 used in conjunction with receiver R.1094, the latter being similar to R.1093 described elsewhere in this publication, but fitted in a box. The diagram is a simplified one showing the method of connecting up the automatic bias, side-tone unit, etc. When housed in a W/T tender, auxiliary equipment such as remote control devices, relays, extra receivers, etc., are required. The installation of the complete station with its auxiliary apparatus will be dealt with elsewhere.

74. Referring to fig. 21, it will be seen that the transmitter and the receiver are connected up in such a way that the aerial is changed over from one to the other by means of an electrically operated change-over switch. Alternative H.T. supplies are shown in the diagram. One of these consists of an 80-watt motor-generator, type E, and the other a 255-watt generator. Each motor is equipped with its own automatic starting device, and a change-over switch enables either H.T. supply to be connected to the transmitter. A smoothing unit is connected in the H.T. supply line.

75. In the diagram it will be seen that the automatic grid-bias is in use. The battery grid-bias is shown to the right of this, the two units being interchangeable. To the left of the automatic grid-bias can be seen the special matching impedance unit which is required when the transmitter is modulated on a line from a remote position. Normally the connections A and B on the transmitter, are connected together by means of a jumper terminating in two plugs. When remote modulation of the transmitter is required plug A is removed, and the plug on the special matching impedance unit is inserted in its place; the secondary of the matching impedance transformer is thereby connected in the grid circuit of the modulator.

76. To the left of the matching impedance unit can be seen the side-tone unit. This is provided with six terminals. The two terminals on the left are connected to $\bar{A}$ and E respectively. The two terminals at the right marked INT., GEN. are connected to a change-over switch and movement of the latter connects the interrupter of the 80-watt generator or the interrupter of the 255-watt generator into circuit in the side-tone unit. The two terminals in the centre are connected up to the INT. terminals on the transmitter. A change-over switch (not shown) is

operated to change from "send" to "receive." This switch operates a number of relays which close various circuits, for example, the aerial change-over switch solenoid, the H.T. supply to the transmitter and the H.T. supply to the receivers.

77. On the right of the diagram can be seen the batteries which supply the L.T. to the transmitter and receiver, and also the anode converter which provides the H.T. supply to the receiver. Two separate batteries are provided one (14-volt) for the 80-watt M/G and one (24-volt) for the 255-watt M/G.

PRECAUTIONS AND MAINTENANCE

78. The tables of adjustments which follow have been prepared on a load representing the aerial system likely to be fitted on a W/T tender. When the transmitter is used with another type of aerial, the aerial tuning and aerial current figures will, of course, not apply. The amplifier tuning figures may also be different.

79. Where the major portion of the traffic is W/T, and particularly where extreme ranges are required, special C.W. or I.C.W. settings (*see* Table 6) may be used. In these circumstances it is recommended that the aerial ammeter be short-circuited by a straight piece of R_4 aerial wire. This is to avoid possible damage consequential upon large aerial currents.

80. Poor quality of speech may be caused by inaccurate adjustment of the anode current ratio of amplifier and modulator valves. The trouble is more likely to occur with insufficient modulator anode current. Over-modulation may also produce distortion. This will be indicated by violent changes of modulator anode current when modulating. To correct this, reduce the loudness of the voice until the modulator anode current milliammeter ceases to kick violently. The possibility of a bad microphone being in use should also be checked. Try tapping the microphone. If this fails to improve the quality, change the microphone.

81. With C.W. there is an increase in aerial current over that obtained on R/T. This is because the load is less on C.W. and the voltage available from the generator is therefore higher. It should be noted that when automatic bias is used this effect is exaggerated owing to the fact that the reduced current through the bias resistances reduces the effective bias. When using the 255-watt generator at maximum power, the current produced in the standard tender aerial will be considerably greater than the aerial ammeter is capable of carrying without damage. If C.W. is to be used therefore, before switching over from R/T to C.W., reduce the aerial coupling or increase the amplifier bias until the aerial current is limited to a value which will not damage the ammeter. If maximum power on C.W. must be used, the ammeter should be shunted as mentioned in para. 62.

82. If, when listening to the C.W. note in the side-tone unit, roughness is detected, the amplifier bias should be increased until a pure note is obtained. It is important to note that if I.C.W. is required the switch on the side-tone unit must be in the "I.C.W. and R/T" position.

83. The voltage of the L.T. battery should be checked periodically on load. Where battery grid-bias is employed the voltage of this should also be checked frequently and any defective 15-volt units renewed. Ensure that all grid-bias battery jumper connections and plugs make proper connection.

84. When the grid-bias battery is used and the H.T. voltage exceeds 1,100 volts, parasitic oscillations are liable to occur in the circuit associated with the modulator valves. In order to prevent these oscillations, two resistances type 263 (100 ohms each) are connected in series between the grids of the modulator valves. The junction-point of the two resistances is taken to the socket engraved A. This modified arrangement is shown in figs. 2, 10, 11 and 12.

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TABLES OF ADJUSTMENTS FOR TRANSMITTER TYPE T.1090

Standard Tender Aerial System. H.T. 1,500 volts on load. 200 watts input (approx.)

Table 1.—Range A (4,286 to 6,667 kcs)

kc/s.	M/O.		Amplifier.							Modulator.				Total input (watts).	Aerial.				
	Tuning.	Anode current mA.	Tuning.			Grid bias.			Neutralizing condenser.	Grid bias.			Total anode current mA.		Plug position.	Tuning.	Coupling (degrees).	Current (amps.).	
			Range 1.	Range 2.	Fixed condenser switch.	Anode current mA.	Volts.	Dial setting.		Volts.	Dial setting.								
6,940	0	33	—	36.0	A	48	236	93	48	65	110	43	146	219	2	1-118	7	1.1	
6,080	30	35	—	114.5	A	43	228	92	48	65	112	45	143	214	2	4-204	14	0.55	
5,300	60	35	—	58.0	B	44	233	93	48	65	111	44	144	216	2	7-158	16	0.82	
4,800	90	35	—	130.0	B	43	226	94	52	60	112	46	138	207	2	9-344	24	0.72	
6,075	30	35	54.0	—	A	43	216	91	60	57	112	47	135	203	2	5-45	25	1.03	
5,295	60	36	118.5	—	A	38	206	92	62	54	115	51	128	192	2	7-263	12	0.8	
4,795	90	36	39.5	—	B	39	210	92	65	56	114	50	131	197	2	10-15	18	0.9	
4,360	120	37	103.5	—	B	40	212	92	66	56	114	49	133	200	2	12-202	21	0.8	
4,050	150	37	29.0	—	C	44	224	92	64	59	110	45	140	210	2	14-335	28	0.88	
3,800	180	38	85.0	—	C	42	226	92	66	62	109	44	142	213	2	17-150	27	0.75	

TABLE 2

Range B (3,000 to 4,615 kc/s)

kc/s.	M/O.		Amplifier.						Modulator.				Total input (watts).	Aerial.			
	Tuning.	Anode current mA.	Tuning.		Anode current mA.	Grid bias		Neutralizing condenser.	Anode current mA.	Grid bias		Total anode current mA.		Plug position.	Tuning.	Coupling (degrees).	Current (amps.).
			Variable condenser.	Fixed condenser switch.		Volts.	Dial setting.			Volts.	Dial setting.						
4,945	0	33	82	A	43	219	92	51	60	112	47	136	204	2	1 304	5	1.28
4,240	30	35	34	B	44	223	94	53	61	110	47	135	203	2	5 292	10	1.2
3,680	60	35	114	B	47	225	90	54	60	109	44	142	213	1	3-35	18	1.27
3,300	90	35	103	C	47	225	90	56	60	110	44	142	213	1	6-33	6	1.0
3,010	120	35	41	D	50	232	92	56	60	113	44	145	218	1	9-3	7	0.95
2,795	150	36	143	D	50	234	92	58	60	109	43	146	219	1	11-277	32	1.0
2,700	165	37	179	D	50	233	90	55	60	109	42	147	221	1	12 360	58	0.95

TABLE 3
Range C (2,000 to 3,409 kc/s)

kc/s.	M.O.			Amplifier.							Modulator.					Aerial.			
	Tuning.			Tuning.				Grid bias.			Neutralizing condenser.	Grid bias.				Plug position.	Tuning.	Coupling (degrees).	Current (amps.).
	Range 1.	Range 2.	Anode current mA.	Range 1.	Range 2.	Fixed con- denser switch.	Anode current mA.	Volts.	Dial setting.	Anode current mA.		Volts.	Dial setting.	Total anode current mA.	Total input (watts).				
3,500	—	0	28	—	149	A	41	206	92	66	59	115	51	128	192	1	2-264	10	1-38
3,130	—	30	27	—	93	B	45	210	91	69	60	110	48	132	198	1	5-320	20	1-4
2,850	—	60	27	—	43	C	47	217	91	68	62	112	47	136	204	1	9-74	20	1-3
2,675	—	90	27	—	103	C	49	220	90	69	64	110	45	140	210	1	11-335	0	1-2
2,540	—	120	27	—	173	C	51	226	91	70	64	109	44	142	213	1	14-99	0	1-2
2,440	—	150	27	—	59	D	51	226	91	69	64	109	44	142	213	1	16-106	0	1-2
2,360	—	180	27	—	101	D	50	229	92	69	65	110	44	142	213	1	17-314	0	1-17
2,980	30	—	28	4	—	A	44	211	91	64	60	113	49	132	198	1	7-237	0	1-3
2,625	60	—	27	147	—	A	49	224	91	64	64	110	45	140	210	1	12-284	0	1-25
2,355	90	—	27	153	—	B	49	226	92	67	64	111	45	140	210	1	18-31	10	1-2
2,145	120	—	28	152	—	C	50	230	92	69	65	113	45	143	215	1	23-98	0	1-15
2,000	150	—	29	123	—	D	50	230	91	70	65	113	45	144	216	1	28-271	0	1-07
1,970	158	—	29	162	—	D	50	229	91	69	65	113	45	144	216	1	30-103	0	1-05

TABLE 4
Range D (1,222 to 2,069 kc/s)

kc/s.	M/O		Amplifier.							Modulator.				Total input (watts).	Aerial.			
	Tuning.	Anode current mA.	Tuning.		Anode current mA.	Grid bias.		Neutralizing condenser.	Anode current mA.	Grid bias.		Total anode current mA.	Plug position.		Tuning.	Coupling (degrees)	Current (amps.)	
			Variable condenser.	Fixed condenser switch.		Volts.	Dial setting.			Volts.	Dial setting.							
2,120	11	24	78	A	47	214	90	54	65	111	47	136	204	1	2	6	1.3	
1,900	30	23	124	A	45	195	84	58	65	113	49	133	200	1	19	0	1.2	
1,690	60	23	58	B	50	207	86	62	65	113	47	138	207	1	45	0	1.4	
1,506	90	22	133	B	50	233	90	64	75	105	41	147	221	1	71	0	1.3	
1,388	120	23	65	C	55	236	91	66	70	112	43	148	222	1	104	0	1.4	
1,284	150	23	136	C	54	247	97	68	68	113	45	145	218	1	132	0	1.35	
1,207	180	24	50	D	52	240	94	71	70	112	44	146	219	1	157	0	1.25	

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TABLE 5
Range E (545 to 857 kc/s)

kc/s.	M/O.		Amplifier.					Modulator.					Aerial.				
			Tuning.			Grid bias.					Grid bias.						
	Tuning.	Anode current mA.	Variable condenser.	Fixed condenser switch	Anode current mA.	Volts.	Dial setting.	Neutralizing condenser.	Anode current mA.	Volts.	Dial setting.	Total anode current mA.	Total input (watts).	Plug position.	Tuning.	Coupling (degrees).	Current (amps.).
896	0	30	123	A	41	216	91	60	65	113	47	136	204	1	22	10	0.9
805	30	29	50	B	47	221	89	66	65	112	45	142	213	1	40	7	1.05
717	60	31	133	B	40	215	90	66	65	113	47	136	204	1	61	4	1.0
650	90	32	104	C	42	222	91	64	65	112	46	139	209	1	78	2	0.95
600	120	34	18	D	42	222	90	69	65	112	45	141	212	1	90	3	0.9
560	150	33	103	D	41	221	91	61	65	113	46	139	209	1	102	5	0.86
540	170	34	169	D	42	224	91	58	65	113	46	141	212	1	112	8	0.75

TABLE 6

Examples of C.W. settings showing high current output

The aerial ammeter has been short-circuited by a piece of R.4 aerial wire

Actual aerial current is shown in brackets.

Fre- quency kc/s.	M/O.			Amplifier.						Neutralizing condenser.	Modu- lator.			Total input (watts).	Aerial.			
	Tuning.		Anode current mA.	Tuning.			Anode current mA.	Grid bias.			Grid bias volts.	Anode current mA.	Total anode current mA.		Plug position.	Tuning.	Coupling (degrees).	Current.
	Range 1.	Range 2.		Range 1.	Range 2.	Fixed con- denser switch		Volts.	Dial setting.									
3,350	—	13.5	28	—	35	B	88	176	87	69	—	—	116	174	1	2-266	25	1 (2.3 amp.).
2,000	150	—	29	123	—	D	90	190	90	70	—	—	120	180	1	28-271	20	0.8 (1.9).

TABLE 7

Ranges C and D (1,222 to 2,069 kc/s)

H.T. supplied by standard 80-watt motor-generator. Battery bias

kc/s.	M/O.			Amplifier.							Modulator.		Aerial.			
	Tuning.		Anode current mA.	Tuning.				Grid bias volts.	Neutralizing condenser.		Grid bias volts.	Anode current mA.	Plug position.	Tuning.	Coupling (degrees).	Current (amps.).
	Range 1.	Range 2.		Range 2.	Range 2.	Fixed condenser switch	Anode current mA.									
3,500	—	0	16	—	149	A	25	120	66		52	50	1	2-264	22	0.7
3,130	—	30	16	—	93	B	26	120	69		52	52	1	5-320	14	0.7
2,850	—	60	16	—	43	C	28	120	68		52	51	1	9-74	18	0.7
2,675	—	90	16	—	103	C	27	120	69		50	55	1	11-335	20	0.65
2,540	—	120	16	—	173	C	28	120	70		50	54	1	14-99	20	0.62
2,440	—	150	16	—	59	D	28	120	69		50	55	1	16-106	20	0.6
2,360	—	180	16	—	101	D	28	120	69		50	54	1	17-314	20	0.56
2,980	30	—	16	4	—	A	27	120	64		50	54	1	7-237	20	0.62
2,625	60	—	16	147	—	A	28	120	64		50	54	1	12-284	20	0.62
2,355	90	—	16	153	—	B	28	120	67		50	54	1	18-31	22	0.56
2,145	120	—	16	152	—	C	28	120	69		50	52	1	23-98	24	0.52
2,000	150	—	16	123	—	D	30	120	70		46	56	1	28-271	30	0.5
1,970	158	—	16	162	—	D	30	120	69		46	56	1	30-103	30	0.5

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APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9337	Transmitter T.1090		Complete, without coils or valves.
	Principal components :—		
10A/5117	Ammeter, thermo, 0 to 1.5 ..	1	
10A/9339	Case	1	Fitted with four mountings, anti-vibration, type 9 (10A/10950).
	Choke, H/F. :—		
10A/8716	Type 22	2	
	Choke, L/F. :—		
10A/9341	Type M	1	Iron core.
	Condenser :—		
10A/8049	Type 144	3	.002 μ F.
10A/8098	Type 146	2	1.0 μ F.
10A/8171	Type 159	1	.000032 μ F.
10A/9342	Type 293	4	.00018 μ F, mica dielectric.
10A/9344	Type 295	1	15 to 130 μ uF, variable, with slow motion handle.
10A/9345	Type 296	1	20 to 220 μ uF, variable, with slow motion handle.
10A/9346	Type 297	1	6 to 30 μ uF, variable, with handle.
10A/9348	Contact, coil	12	
	Holder, valve :—		
10A/3412	Type V.T.13	4	
	Milliammeter :—		
10A/3191	0 to 200, type A	1	
	Plug :—		
10A/7153	Type 29	14	Single pole, circular body.
10A/7328	Type 43	3	Single pole, circular body.
	Resistance :—		
10A/7315	Type 41	1	40,000 to 45,000 ohms, rod type.
10A/8016	Type 108	1	.5 M Ω rod type.
10A/9349	Type 249	1	20,000 ohms, rod type.
10A/9350	Type 250	1	40,000 ohms, 3-watt, rod type.
10A/9351	Type 251	2	10,000 ohms, 30-watt, rod type.
10A/9099	Type 263	2	100 ohms.
	Socket :—		
10A/9352	Type 47	17	Single pole.
	Switch :—		
10A/9353	Type 103	1	4-way, barrel type.
10A/9354	Type 104	1	3-way, barrel type.
10A/9355	Type 105	1	3-way, barrel type.
10A/9356	Type 106	1	2-way, barrel type.
	Transformer, microphone :—		
10A/7785	Type E	1	
	Accessories :—		
	Case, transit :—		
10A/9358	Coils	5	To hold one each aerial, amplifier, and M/O coils.
10A/9359	Transmitter	1	

APPENDIX—*contd.*

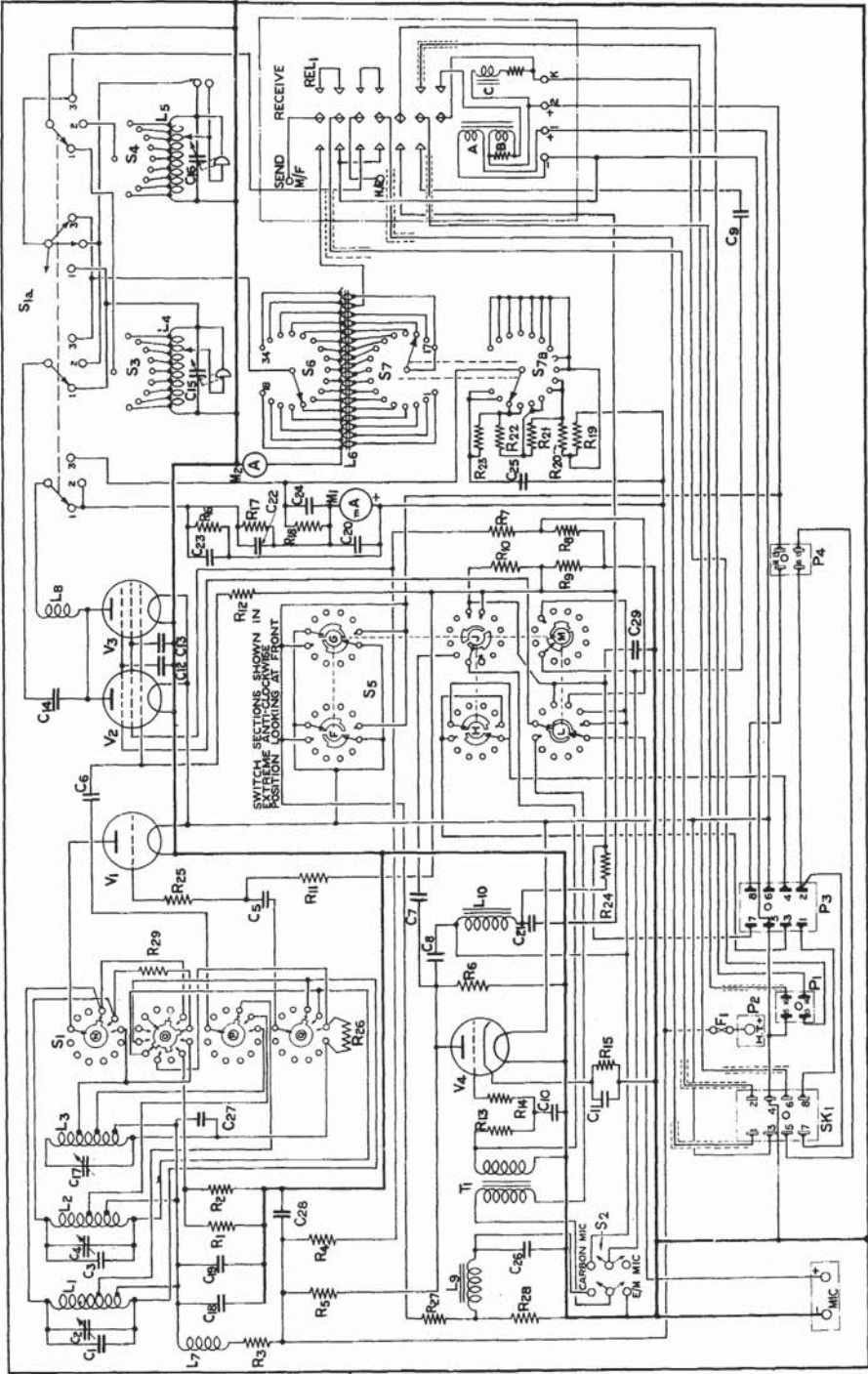
Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter T.1090— <i>continued</i> Accessories— <i>continued</i> .		
	Coil, aerial :—		
10A/9338	Range A	1	4,286 to 6,667 kc/s, variable, with counting mechanism.
10A/9360	Ranges B and C	2	2,000 to 4,615 kc/s, variable, with counting mechanism. One coil in range B and one in range C transit case.
10A/9361	Range D	1	1,222 to 2,069 kc/s, variometer.
10A/9362	Range E	1	545 to 857 kc/s, variometer.
	Coil, amplifier :—		
10A/9363	Range A	1	4,286 to 6,667 kc/s, fitted with switch and variable coupling coil.
10A/9364	Range B	1	4,615 to 3,000 kc/s, fitted with variable coupling coil.
10A/9365	Range C	1	2,000 to 3,409 kc/s, fitted with switch, variable coupling coil and one condenser, type 300.
10A/9366	Range D	1	1,222 to 2,069 kc/s, fitted with variable coupling coil.
10A/9367	Range E	1	545 to 857 kc/s, fitted with variable coupling coil.
	Coil, master-oscillator :—		
10A/9368	Range A	1	4,286 to 6,667 kc/s.
10A/9369	Range B	1	4,615 to 3,000 kc/s.
10A/9370	Range C	1	2,000 to 3,409 kc/s, fitted with switch and one condenser, type 293.
10A/9371	Range D	1	1,222 to 2,069 kc/s.
10A/9372	Range E	1	545 to 857 kc/s, fitted with two condensers, type 159.
10A/7312	Valve, type V.T.25	4	

CONCISE DETAILS OF TRANSMITTERS T.1154, T.1154A, AND T.1154B

PURPOSE OF EQUIPMENT	Air-borne transmitter		
TYPE OF WAVE	T.1154 and T.1154B. - C.W., M.C.W. or R/T. T.1154A, C.W. and M.C.W.		
FREQUENCY RANGE	10 Mc/s—3 M/cs and 500 kc/s—200 kc/s.		
FREQUENCY STABILITY	Master-oscillator		
CRYSTAL MULT. FACTOR	Not applicable		
PERCENTAGE MODULATION	100 per cent; 80 per cent. on M.C.W.		
MAXIMUM SENSITIVITY	Not applicable		
SELECTIVITY	Not applicable		
OUTPUT IMPEDANCE	Variable by anode and aerial tapplings on tuning inductance, anode tapplings on M.F. and aerial tapplings on H.F.		
AMPLIFIER CLASS	Parallel power-amplifier stage		
MICROPHONE TYPE	Carbon-granule or electro-magnetic (with amplifier A.1134)		
VALVES	Master-oscillator and modulator, V.T.106 (Stores Ref. 10E/216) Amplifiers (2), V.T. 104 (Stores Ref. 10E/215)		
POWER INPUT	L.T. 45 watts, on full load Power Unit, type 34, input 10.3 v. D.C. (nominal 12 v.), output 7 v., 13 amp. D.C. and 217 volts 110 mA D.C. Overall input approx. 232 watts. Power unit, type 35, input 18.5 v. D.C. (nominal 24 v.), output 7 v., 13 amp. D.C. and 217 volts, 110 mA. D.C. Overall input approx. 232 watts. H.T. input 13.2 volts D.C., output 1,200 v., 200 mA. Overall input approx. 480 watts. } Also supplies receiver R.1155 H.T. and L.T.		
POWER OUTPUT	40 watts., max.		
STORES REF. NO.	T.1154—Stores Ref. 10D/97; T.1154A—Stores Ref. 10D/99; T.1154B—Stores Ref. 10D/196.		
APPROXIMATE OVERALL DIMENSIONS	LENGTH 17½ in.	WIDTH 16⅜ in.	HEIGHT 11 in.
WEIGHT	45 lb. power units weigh 40 lb. 4 oz. and 27 lb. 12 oz.		
ASSOCIATED EQUIPMENT	L.T. power unit, type 34 (Stores Ref. 10K/19) or type 35 (Stores Ref. 10K/20) of Type 34X (Stores Ref. 10K/61) H.T. power unit, type 32 (Stores Ref. 10K/17) or type 33 (Stores Ref. 10K/28) Amplifier A.1134 (Stores Ref. 10U/1150) for electro-magnetic micro-phones Receiver R.1155 (Stores Ref. 10D/98).		

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CONDENSERS				CONDENSERS			
C1	C2	C3	C4	C5	C6	C7	C8
C9	C10	C11	C12	C13	C14	C15	C16
C17	C18	C19	C20	C21	C22	C23	C24
C25	C26	C27	C28	C29	C30	C31	C32
C33	C34	C35	C36	C37	C38	C39	C40
C41	C42	C43	C44	C45	C46	C47	C48
C49	C50	C51	C52	C53	C54	C55	C56
C57	C58	C59	C60	C61	C62	C63	C64
C65	C66	C67	C68	C69	C70	C71	C72
C73	C74	C75	C76	C77	C78	C79	C80
C81	C82	C83	C84	C85	C86	C87	C88
C89	C90	C91	C92	C93	C94	C95	C96
C97	C98	C99	C100	C101	C102	C103	C104
C105	C106	C107	C108	C109	C110	C111	C112
C113	C114	C115	C116	C117	C118	C119	C120
C121	C122	C123	C124	C125	C126	C127	C128
C129	C130	C131	C132	C133	C134	C135	C136
C137	C138	C139	C140	C141	C142	C143	C144
C145	C146	C147	C148	C149	C150	C151	C152
C153	C154	C155	C156	C157	C158	C159	C160
C161	C162	C163	C164	C165	C166	C167	C168
C169	C170	C171	C172	C173	C174	C175	C176
C177	C178	C179	C180	C181	C182	C183	C184
C185	C186	C187	C188	C189	C190	C191	C192
C193	C194	C195	C196	C197	C198	C199	C200
C201	C202	C203	C204	C205	C206	C207	C208
C209	C210	C211	C212	C213	C214	C215	C216
C217	C218	C219	C220	C221	C222	C223	C224
C225	C226	C227	C228	C229	C230	C231	C232
C233	C234	C235	C236	C237	C238	C239	C240
C241	C242	C243	C244	C245	C246	C247	C248
C249	C250	C251	C252	C253	C254	C255	C256
C257	C258	C259	C260	C261	C262	C263	C264
C265	C266	C267	C268	C269	C270	C271	C272
C273	C274	C275	C276	C277	C278	C279	C280
C281	C282	C283	C284	C285	C286	C287	C288
C289	C290	C291	C292	C293	C294	C295	C296
C297	C298	C299	C300	C301	C302	C303	C304
C305	C306	C307	C308	C309	C310	C311	C312
C313	C314	C315	C316	C317	C318	C319	C320
C321	C322	C323	C324	C325	C326	C327	C328
C329	C330	C331	C332	C333	C334	C335	C336
C337	C338	C339	C340	C341	C342	C343	C344
C345	C346	C347	C348	C349	C350	C351	C352
C353	C354	C355	C356	C357	C358	C359	C360
C361	C362	C363	C364	C365	C366	C367	C368
C369	C370	C371	C372	C373	C374	C375	C376
C377	C378	C379	C380	C381	C382	C383	C384
C385	C386	C387	C388	C389	C390	C391	C392
C393	C394	C395	C396	C397	C398	C399	C400
C401	C402	C403	C404	C405	C406	C407	C408
C409	C410	C411	C412	C413	C414	C415	C416
C417	C418	C419	C420	C421	C422	C423	C424
C425	C426	C427	C428	C429	C430	C431	C432
C433	C434	C435	C436	C437	C438	C439	C440
C441	C442	C443	C444	C445	C446	C447	C448
C449	C450	C451	C452	C453	C454	C455	C456
C457	C458	C459	C460	C461	C462	C463	C464
C465	C466	C467	C468	C469	C470	C471	C472
C473	C474	C475	C476	C477	C478	C479	C480
C481	C482	C483	C484	C485	C486	C487	C488
C489	C490	C491	C492	C493	C494	C495	C496
C497	C498	C499	C500	C501	C502	C503	C504
C505	C506	C507	C508	C509	C510	C511	C512
C513	C514	C515	C516	C517	C518	C519	C520
C521	C522	C523	C524	C525	C526	C527	C528
C529	C530	C531	C532	C533	C534	C535	C536
C537	C538	C539	C540	C541	C542	C543	C544
C545	C546	C547	C548	C549	C550	C551	C552
C553	C554	C555	C556	C557	C558	C559	C560
C561	C562	C563	C564	C565	C566	C567	C568
C569	C570	C571	C572	C573	C574	C575	C576
C577	C578	C579	C580	C581	C582	C583	C584
C585	C586	C587	C588	C589	C590	C591	C592
C593	C594	C595	C596	C597	C598	C599	C600
C601	C602	C603	C604	C605	C606	C607	C608
C609	C610	C611	C612	C613	C614	C615	C616
C617	C618	C619	C620	C621	C622	C623	C624
C625	C626	C627	C628	C629	C630	C631	C632
C633	C634	C635	C636	C637	C638	C639	C640
C641	C642	C643	C644	C645	C646	C647	C648
C649	C650	C651	C652	C653	C654	C655	C656
C657	C658	C659	C660	C661	C662	C663	C664
C665	C666	C667	C668	C669	C670	C671	C672
C673	C674	C675	C676	C677	C678	C679	C680
C681	C682	C683	C684	C685	C686	C687	C688
C689	C690	C691	C692	C693	C694	C695	C696
C697	C698	C699	C700	C701	C702	C703	C704
C705	C706	C707	C708	C709	C710	C711	C712
C713	C714	C715	C716	C717	C718	C719	C720
C721	C722	C723	C724	C725	C726	C727	C728
C729	C730	C731	C732	C733	C734	C735	C736
C737	C738	C739	C740	C741	C742	C743	C744
C745	C746	C747	C748	C749	C750	C751	C752
C753	C754	C755	C756	C757	C758	C759	C760
C761	C762	C763	C764	C765	C766	C767	C768
C769	C770	C771	C772	C773	C774	C775	C776
C777	C778	C779	C780	C781	C782	C783	C784
C785	C786	C787	C788	C789	C790	C791	C792
C793	C794	C795	C796	C797	C798	C799	C800
C801	C802	C803	C804	C805	C806	C807	C808
C809	C810	C811	C812	C813	C814	C815	C816
C817	C818	C819	C820	C821	C822	C823	C824
C825	C826	C827	C828	C829	C830	C831	C832
C833	C834	C835	C836	C837	C838	C839	C840
C841	C842	C843	C844	C845	C846	C847	C848
C849	C850	C851	C852	C853	C854	C855	C856
C857	C858	C859	C860	C861	C862	C863	C864
C865	C866	C867	C868	C869	C870	C871	C872
C873	C874	C875	C876	C877	C878	C879	C880
C881	C882	C883	C884	C885	C886	C887	C888
C889	C890	C891	C892	C893	C894	C895	C896
C897	C898	C899	C900	C901	C902	C903	C904
C905	C906	C907	C908	C909	C910	C911	C912
C913	C914	C915	C916	C917	C918	C919	C920
C921	C922	C923	C924	C925	C926	C927	C928
C929	C930	C931	C932	C933	C934	C935	C936
C937	C938	C939	C940	C941	C942	C943	C944
C945	C946	C947	C948	C949	C950	C951	C952
C953	C954	C955	C956	C957	C958	C959	C960
C961	C962	C963	C964	C965	C966	C967	C968
C969	C970	C971	C972	C973	C974	C975	C976
C977	C978	C979	C980	C981	C982	C983	C984
C985	C986	C987	C988	C989	C990	C991	C992
C993	C994	C995	C996	C997	C998	C999	C1000



T.1154 - THEORETICAL CIRCUIT DIAGRAM

FIG. 2

CONDENSERS			
C27	40 μ F	C1	10 μ F
C28	0.04 μ F	C2	10 μ F
C29	0.1 μ F	C3	10 μ F
C30	0.1 μ F	C4	10 μ F
C31	0.1 μ F	C5	10 μ F
C32	0.1 μ F	C6	10 μ F
C33	0.1 μ F	C7	10 μ F
C34	0.1 μ F	C8	10 μ F
C35	0.1 μ F	C9	10 μ F
C36	0.1 μ F	C10	10 μ F
C37	0.1 μ F	C11	10 μ F
C38	0.1 μ F	C12	10 μ F
C39	0.1 μ F	C13	10 μ F
C40	0.1 μ F	C14	10 μ F
C41	0.1 μ F	C15	10 μ F
C42	0.1 μ F	C16	10 μ F
C43	0.1 μ F	C17	10 μ F
C44	0.1 μ F	C18	10 μ F
C45	0.1 μ F	C19	10 μ F
C46	0.1 μ F	C20	10 μ F
C47	0.1 μ F	C21	10 μ F
C48	0.1 μ F	C22	10 μ F
C49	0.1 μ F	C23	10 μ F
C50	0.1 μ F	C24	10 μ F
C51	0.1 μ F	C25	10 μ F
C52	0.1 μ F	C26	10 μ F

RESISTANCES	
R1	50,000 Ω
R2	50,000 Ω
R3	50,000 Ω
R4	20,000 Ω
R5	75,000 Ω
R6	75,000 Ω
R7	12,000 Ω
R8	20,000 Ω
R9	5,000 Ω
R10	350 Ω
R11	15,000 Ω
R12	20,000 Ω
R13	650 Ω
R14	75,000 Ω
R15	800 Ω
R16	10 Ω
R17	15.5 Ω
R18	10 Ω
R19	10 Ω
R20	2.9 Ω
R21	5.3 Ω
R22	12.6 Ω
R23	69.2 Ω
R24	500 Ω
R25	5 Ω
R26	510 Ω
R27	10 Ω
R28	6 Ω
R29	150 Ω

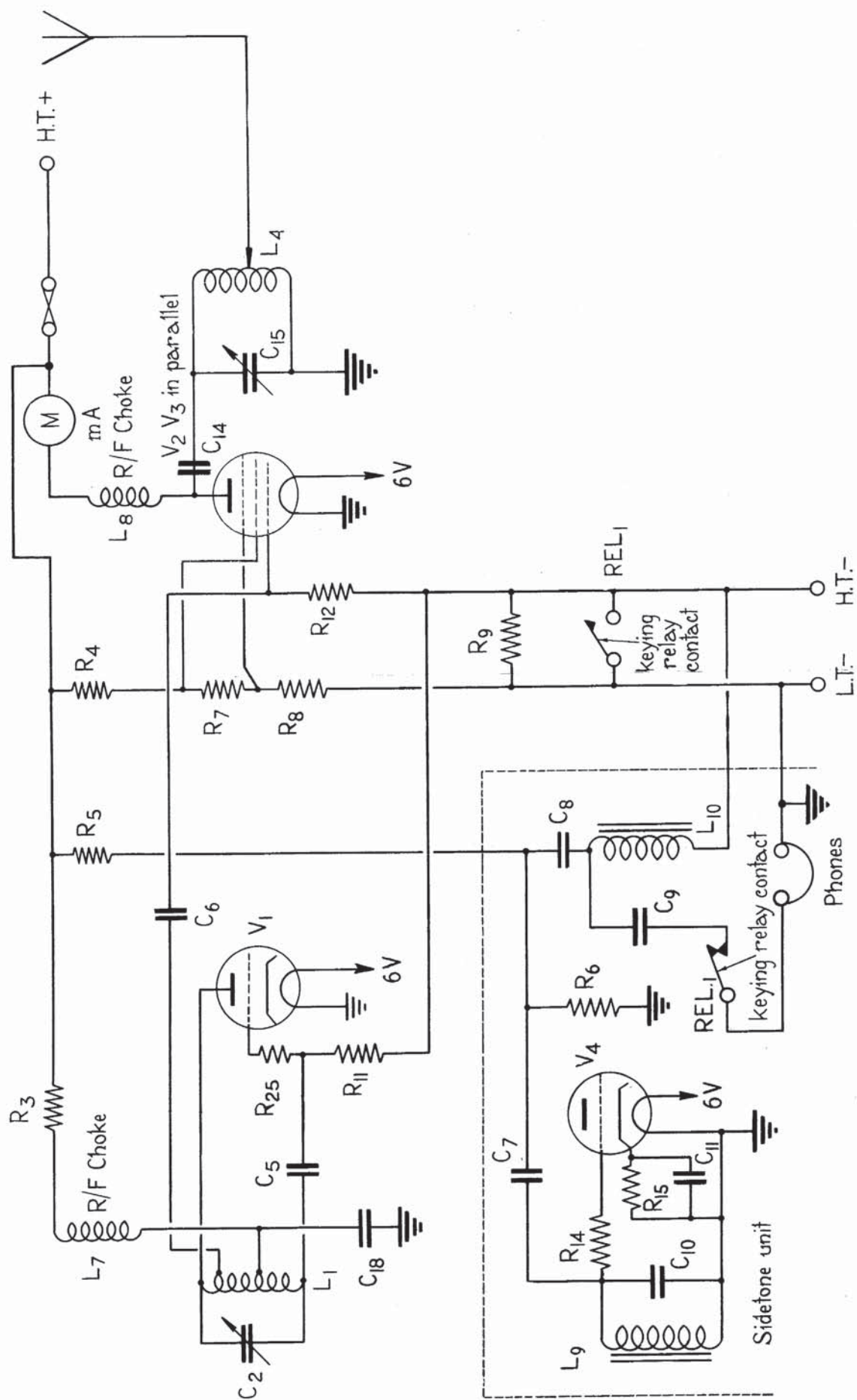


FIG. 3.

SIMPLIFIED CIRCUIT FOR C.W. RANGE I

FIG. 3.

A.P.1186, VOL. I, SECT. 1, CHAP. 7.

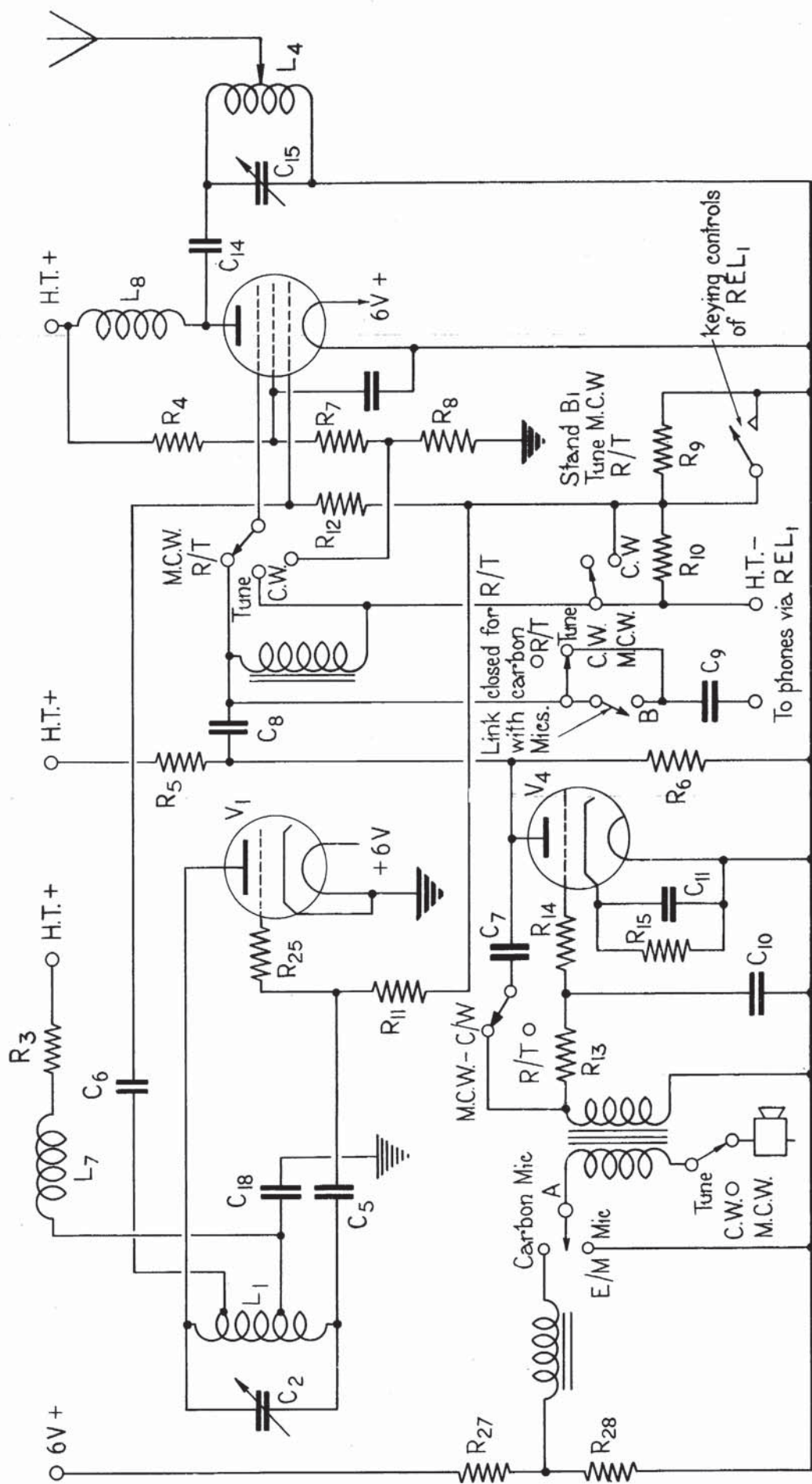


FIG. 4.

SIMPLIFIED CIRCUIT OF SWITCHING ARRANGEMENTS IN RANGE I (H/F)

FIG. 4.

A.P. 1186, VOL. I, SECT. I, CHAP. 7.

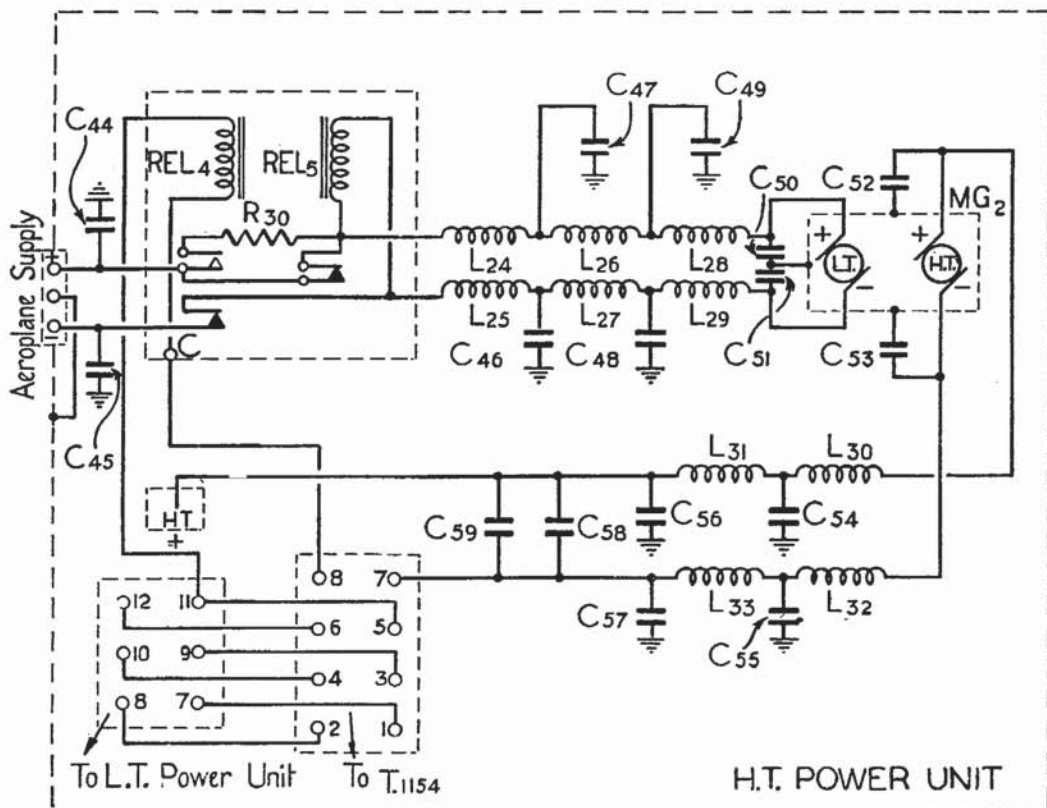
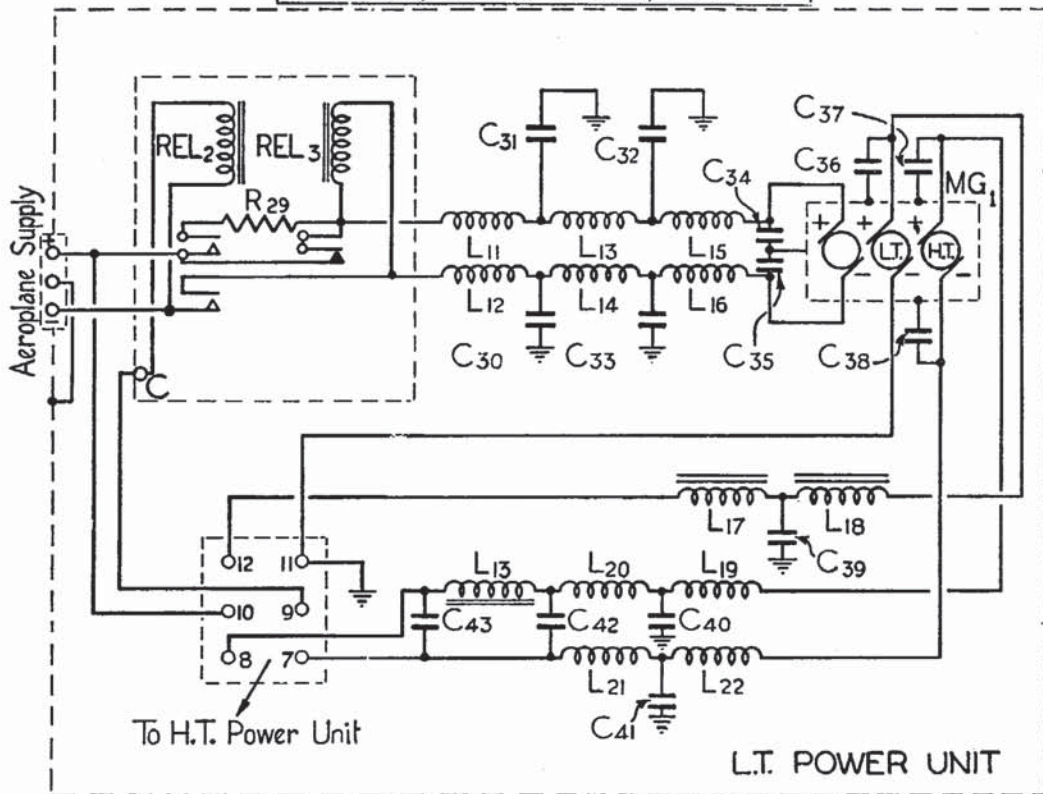


FIG. 5

T.1154 POWER UNITS

FIG. 5

**CONCISE DETAILS OF
TRANSMITTERS, TYPES T.1154, T.1154A, T.1154B, T.1154C, T.1154D AND T.1154E**

PURPOSE OF EQUIPMENT	Two-way communication airborne transmitters used in conjunction with receivers of the R.1155 group. Work into either fixed or trailing aeriels. The T.1154D and T.1154E are applications to mobile, use normally used with foreign receivers. Colour-coded controls			
TYPE OF WAVE	T.1154, T.1154B, T.1154C, T.1154D:—R/T, M.C.W., C.W. T.1154A, T.1154E:—M.C.W., C.W.			
FREQUENCY RANGE	T.1154, T.1154A, T.1154B:—10.0 Mc/s–3.0 Mc/s and 500 kc/s–200 kc/s in 3 ranges (Blue, Red, Yellow). T.1154C:—16.7 Mc/s–2.35 Mc/s and 500 kc/s–200 kc/s in 4 ranges (Blue, Blue, Red, Yellow). T.1154D, T.1154E:—8 Mc/s–2.5 Mc/s and 500 kc/s–200 kc/s in 3 ranges (Blue, Red, Yellow)			
FREQUENCY STABILITY	Master-oscillator			
CRYSTAL MULT. FACTOR	Not applicable			
PERCENTAGE MODULATION	70 per cent.			
MAXIMUM SENSITIVITY	Not applicable			
SELECTIVITY	Not applicable			
OUTPUT IMPEDANCE	Not applicable			
AMPLIFIER CLASS	Class A, suppressor grid modulated			
MICROPHONE TYPE	Carbon granule or electro-magnetic with sub-modulator such as A.1134 or A.1134A			
VALVES	Master oscillator, tone oscillator, and modulator, two indirectly heated triodes, V.T.105 (Stores Ref. 10E/216) Power amplifier, two directly heated pentodes, V.T.104 (Stores Ref. 10E/215)			
POWER INPUT	From 12 volts or 24 volts rotary transformer in conjunction with aircraft general electrical supply. 230 volts, 50 cycles, A.C. mains with rectifier used for ground application. 1,200 volts, 200 mA, H.T.; 6 volts, 4 amps., L.T.; 6 volts, 2.5 amps, relay; (approx. 280 watts)			
POWER OUTPUT	BLUE range. 0.25–0.6 amp. R/T, 0.4–1.0 amp. C.W., 0.27–0.65 amp. M.C.W. RED range. 0.8–1.25 amps. R/T, 1.7–2.4 amps. C.W., 1.0–1.6 amps. M.C.W. YELLOW range. 1.0 amp. R/T, 1.1–1.8 amps. C.W., 0.8–1.0 amp. M.C.W. T.1154C output generally slightly lower than the above			} Into typical aeriels
STORES REF No.	T.1154, 10D/97; T.1154A, 10D/99; T.1154B, 10D/196; T.1154C, 10D/198; T.1154D, 10D/730; T.1154E, 10D/731			
APPROXIMATE OVERALL DIMENSIONS	LENGTH 17½ in.	WIDTH 16½ in.	HEIGHT 11½ in.	
WEIGHT	Approx. 46 lb. 10 oz. with suspension units and valves			
ASSOCIATED EQUIPMENT	R.1155 (Stores Ref. 10D/98), R.1155A (Stores Ref. 10D/820), R.1155B (Stores Ref. 10D/13045), Morse key, type F (Stores Ref. 10F/7741) Switch unit, type J (Stores Ref. 10F/126), or aerial plug board (Stores Ref. 10H/681) Impedance matching unit, type 111 (Stores Ref. 10A/13157) Connector sets according to type of aircraft Power unit— type 32 (Stores Ref. 10K/17), or type 32A (Stores Ref. 10K/13063) type 33 (Stores Ref. 10K/18), or type 33A (Stores Ref. 10K/13064) type 34x (Stores Ref. 10K/61), or type 34A (Stores Ref. 10K/13065), or type 34 (Stores Ref. 10K/19), type 35A (Stores Ref. 10K/13066), or type 35 (Stores Ref. 10K/20) For use on ground. Power unit, type 114 (Stores Ref. 10K/350), and type 115 (Stores Ref. 10K/351). For mobile ground station, with rectifier, type 26 (Stores Ref. 10D/745)			

SECTION 1—CHAPTER " "

TRANSMITTERS, TYPES T.1154, T.1154A, T.1154B, T.1154C, T.1154D AND T.1154E

WITH APPENDIX ON T.1154F, G, H, J, K, L, M, N, and P.

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TRANSMITTER TYPE T.1154F, G, H, J, K, L, M, N, P.

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TYPICAL TRANSMITTER FITTED WITH UNICLIK STOP MECHANISM

DETAILS OF UNI CLICKSTOP MECHANISM 2/60 269

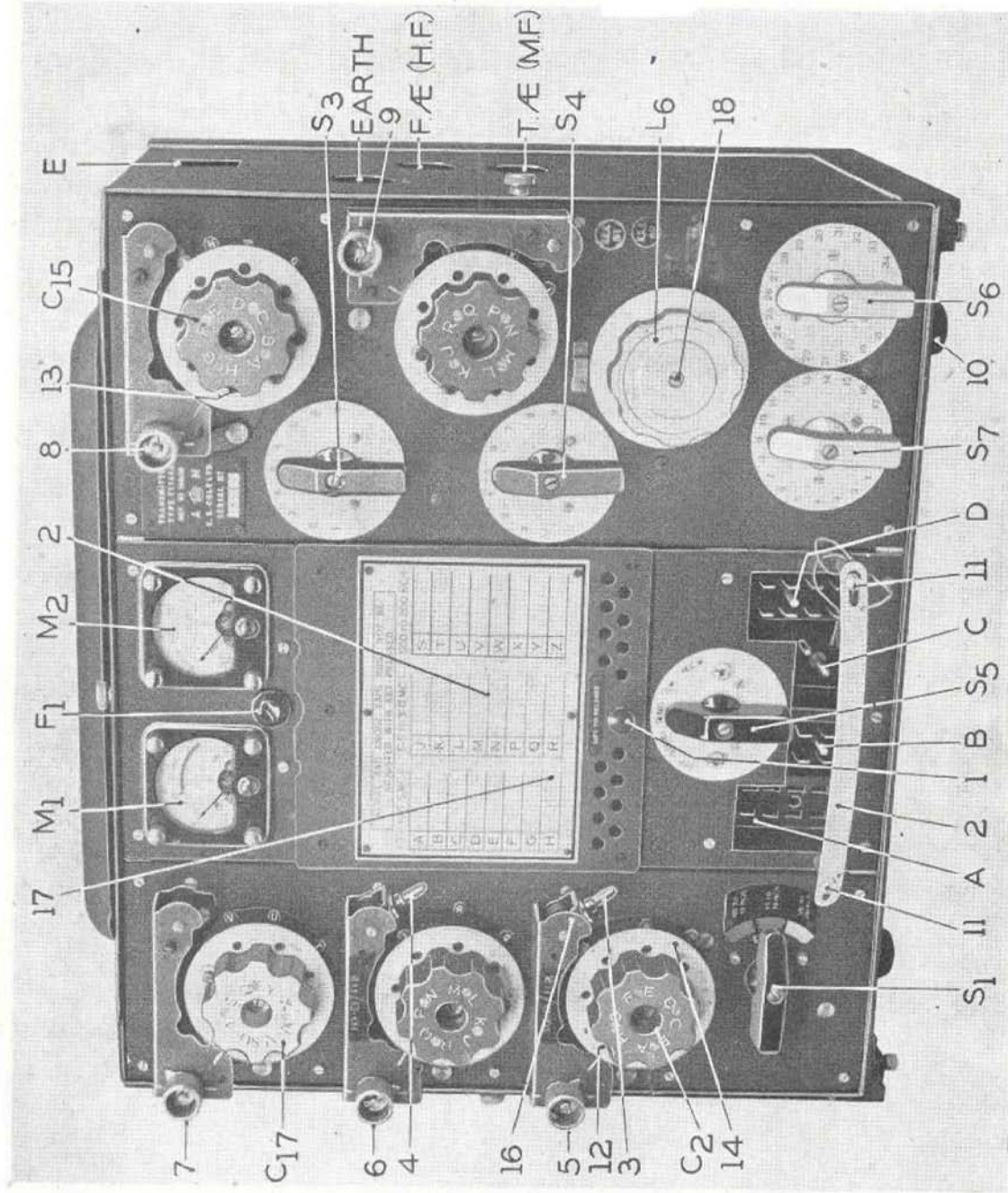


FIG. 1.—TRANSMITTER T.1154

TRANSMITTERS, TYPES T.1154, T.1154A, T.1154B, T.1154C, T.1154D AND T.1154E

INTRODUCTION

1. The transmitters of the T.1154 group are, primarily, intended for use in aircraft to provide two-way communication, air-to-air and air-to-ground. They are normally, but not invariably, used in conjunction with the communications and D/F receivers of the R.1155 group and provision is made for switching interlock between the installed instruments. There is little difference between the T.1154 (Stores Ref. 10D/97) and T.1154B (Stores Ref. 10D/196) which may be used for R/T, C.W. and M.C.W. The T.1154C (Stores Ref. 10D/198) gives similar facilities but with an extended frequency coverage. The T.1154A (Stores Ref. 10D/99) provides for C.W. and M.C.W. operation only. A mobile application uses the T.1154D (Stores Ref. 10D/730) for R/T, C.W. and M.C.W. and the T.1154E (Stores Ref. 10D/731) for C.W. and M.C.W. only. These two types have a modified frequency coverage and are wired for operation independently of the receiver.

2. Frequency selection in all versions of this transmitter can be effected by the use of a pre-selector "click-stop" mechanism giving a total of eight "spot" frequencies for each range and of any value within the particular range. The term RANGE is used in this chapter as a convenient means of describing the individual bands of frequencies but is not actually engraved upon the instrument, the controls of which are colour-coded in accordance with the accompanying schedule. This colour code is applied, for facility of operation, to the receivers of the R.1155 group.

T.1154, T.1154A, T.1154B

- RANGE 1 (H.F.), BLUE, 10 Mc/s. to 5.5 Mc/s.
- RANGE 2 (H.F.), RED, 5.5 Mc/s. to 3.0 Mc/s.
- RANGE 3 (M.F.), YELLOW, 500 kc/s. to 200 kc/s.

T.1154C

- RANGE 1 (H.F.), BLUE, 16.7 Mc/s. to 8.7 Mc/s.
- RANGE 2 (H.F.), BLUE, 8.7 Mc/s. to 4.5 Mc/s.
- RANGE 3 (H.F.), RED, 4.5 Mc/s. to 2.35 Mc/s.
- RANGE 4 (M.F.), YELLOW, 500 kc/s. to 200 kc/s.

T.1154D, T.1154E

- RANGE 1 (H.F.), BLUE, 8 Mc/s. to 4.5 Mc/s.
- RANGE 2 (H.F.), RED, 4.5 Mc/s. to 2.5 Mc/s.
- RANGE 3 (M.F.), YELLOW, 500 kc/s. to 200 kc/s.

3. On airborne equipment switching provision is made for operation into either fixed or trailing aerials by means of an independent aerial selector switch, type J, which also controls the interlocking of the H.T. supplies. Alternatively, an aerial plug board is used. Fixed aerials may be of any length between 25 ft. and 65 ft. including the lead in, 45 ft. being approximately an optimum length for single wire aerials. Trailing aerials are of the standard service type of 200 ft. For mobile use the T.1154D and T.1154E are fed into vertical aerials for remote working and into triatic suspended arrays for local working.

4. The circuit of the transmitter is based upon a master oscillator (M.O.) triode stage driving a power amplifier comprising two pentode valves in parallel. An additional triode valve is used for R/T modulation or as a tone oscillator of approximately 1,200 c/s on C.W. and M.C.W. providing keying side-tone and tone modulation. Output loading is effected by means of tapped coils on the H.F. ranges with an additional anode tap for the M.F. range.

5. With the exception of the BLUE RANGES 1 and 2 of T.1154C, which are obtained on the same oscillator and output controls, each RANGE throughout the group of transmitters is covered by a separate L/C circuit in both oscillator and amplifier stages. Any range can be obtained by the operation of a switch which selects the oscillator and the corresponding output circuit. Pre-selection of "spot" frequencies is arranged through a special "click-stop" mechanism to which vernier adjustment may be applied, on the H.F. RANGES.

6. Either carbon granule or electro-magnetic type microphones may be used for R/T with the transmitters equipped for telephony transmission but when electro-magnetic microphones are used it is necessary to incorporate a suitable sub-modulating device such as the intercommunication (I/C) amplifier A.1134 (Stores Ref. 10U/11500) to provide the necessary microphone gain. The change from carbon to electro-magnetic operation entails a minor internal modification to the transmitter (see para. 47). A detailed description of the amplifier A.1134 is given in Sect. 4, Chap. 2 of this publication. When using the A.1134, I/C is available and side-tone is provided from the amplifier.

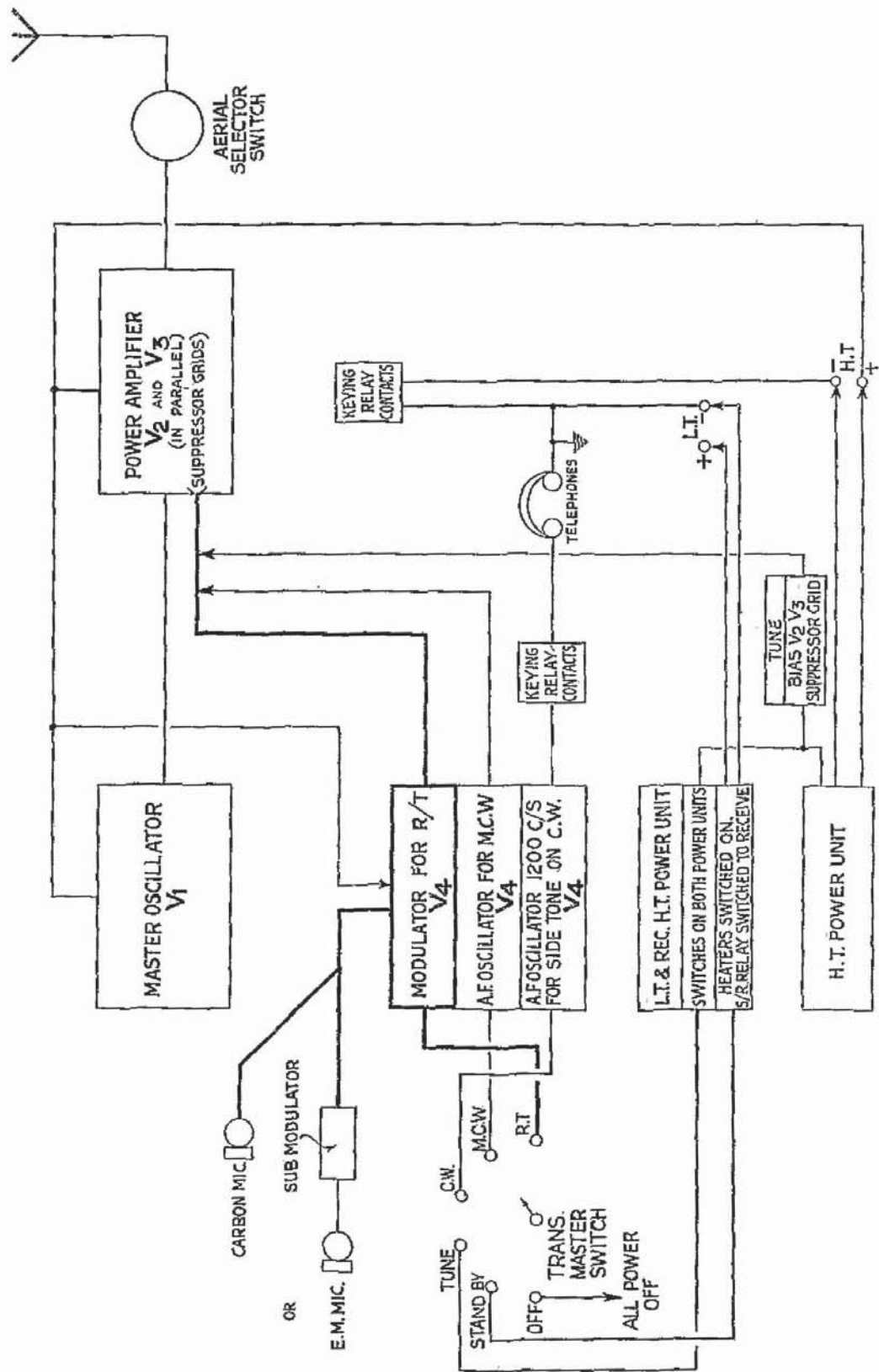


FIG. 2.—SCHEMATIC DIAGRAM OF TRANSMITTER

7. Power supplies for the airborne equipment are derived from the general aircraft electrical supply system of nominal 12-volt or 24-volt rating, through two power units which include rotary transformers and the necessary smoothing and filtering circuits. One of these units (referred to as the H.T. power unit) supplies the H.T., and the other (the L.T. power unit) provides the L.T. The L.T. power unit is used in common with the receiver installation, supplying both H.T. and L.T. for the receiver. The T.1154D and T.1154E are operated from a 230 volts, A.C. single-phase, 50 c/s supply through suitable rectifier power units. For training purposes the equipment is normally supplied with direct current from these rectifier power units, such as the power unit, type 114 (Stores Ref. 10K/350), from the A.C. mains or from the standard airborne rotary transformer power units actuated through a 24-28 volts rectifier unit, such as the power unit, type 115 (Stores Ref. 10K/351) connected to the A.C. mains.

8. The overall dimensions of a transmitter, in its case, are approximately $17\frac{1}{2}$ in. by $16\frac{3}{4}$ in. by $11\frac{1}{2}$ in. The weight of the instrument, complete with its suspension units and valves, is approximately 46 lb. 10 oz. The general appearance of a transmitter T.1154 is shown in fig. 1 and this illustration is representative of the remaining types except for the additional socket required for the R/T versions.

GENERAL DESCRIPTION.

9. A schematic diagram of the transmitter, including R/T, is given in fig. 2. A complete circuit diagram of the T.1154A, that is, for C.W. and M.C.W. operation only, is shown in fig. 3. A simplified circuit for C.W. on RANGE 1 of R.1154A is given in fig. 4. A complete circuit diagram of the R.1154, for R/T, C.W. and M.C.W. operation is shown in fig. 5 and a simplified circuit of the keying and switching arrangements in RANGE 1 is shown in fig. 6.

10. Variations in the types of this transmitter arise from the inclusion of R/T facilities or through differences in frequency coverage. The basic circuit is unchanged and this consists of a master-oscillator control stage arranged as a series-feed Hartley-type oscillator in which the tuned circuit is connected between the anode and grid of an indirectly-heated triode valve V_1 .

11. Oscillation set up across the whole of the tuned circuit coil produces an oscillatory voltage across that portion of the coil connected between the grid and cathode. The cathode tap is also the H.T. tapping point, that is, the point on the coil through which the H.T. positive is supplied to the anode of V_1 . This common tap is at earth potential to R.F. and adjusts the portion of the oscillatory circuit which is fed back between grid and cathode. The optimum condition for self-oscillation is, however, obtained because the oscillatory voltage between grid and cathode is always in anti-phase to the anode (top end) and cathode oscillatory potential difference.

12. The common tapping point is connected to the cathode through two condensers C_{18} and C_{19} (in parallel) which have a low impedance to R.F. while isolating the H.T. supply. Thus this point is maintained at cathode potential to R.F. It should be pointed out, however, that in this circuit, the cathode is connected to chassis which is at a positive potential to the negative H.T. supply terminal due to the voltage drop through R_{10} , R_9 and the keying relay contacts through which the whole of the H.T. current for the transmitter flows.

13. Grid bias is obtained by grid leak and condenser C_6 , R_{11} . When the key is up, this grid bias is increased by the voltage dropped across R_9 , which becomes shorted by means of contacts in the keying relay when the key is pressed. A resistance R_4 in the H.T. positive line serves to reduce the anode voltage of the oscillator valve. When the key is up, the increased bias reduces the anode current, giving less voltage drop in R_9 and a higher anode voltage to V_1 which helps this valve to commence to oscillate when the key is pressed. The increase of anode current then gives more drop in R_9 and reduces the anode current to the normal working value.

14. The output from the tuned circuit is coupled, through a condenser C_6 , to the control grids of a power-amplifier stage consisting of two directly-heated pentodes V_2 and V_3 connected in parallel. The grid current flowing in the power amplifier valves causes the input to have a low impedance which is matched in the oscillator circuit by means of a tapping on the coil.

15. On RANGES 1 and 2 of all transmitters the output circuit is parallel consisting of a coil tuned by a variable condenser. The loading is effected by tapping the aerial to a suitable point on the coil through a tap selector switch. On RANGE 3 (H.F.) of the T.1154C the coil is disconnected from earth to act as an aerial loading coil, the circuit being completed through the aerial capacitance. The circuit is completed by the aerial capacitance.

16. On RANGE 3 (M.F.) of transmitters, other than the T.1154C, and on RANGE 4 of the T.1154C, a parallel fed circuit is retained. The aerial provides a tank circuit capacitance, the tuning being obtained by a switch which taps the amount of inductance in circuit and short-circuits the unwanted portion of the coil. A fine tuning control adjusts the value of inductance between the tapping points by varying the permeability of the core. Loading of the output stage is adjusted by tapping the anodes of the output valves *via* a tap selector switch to the aerial coil.

Note:—To be read in conjunction with fig. 3

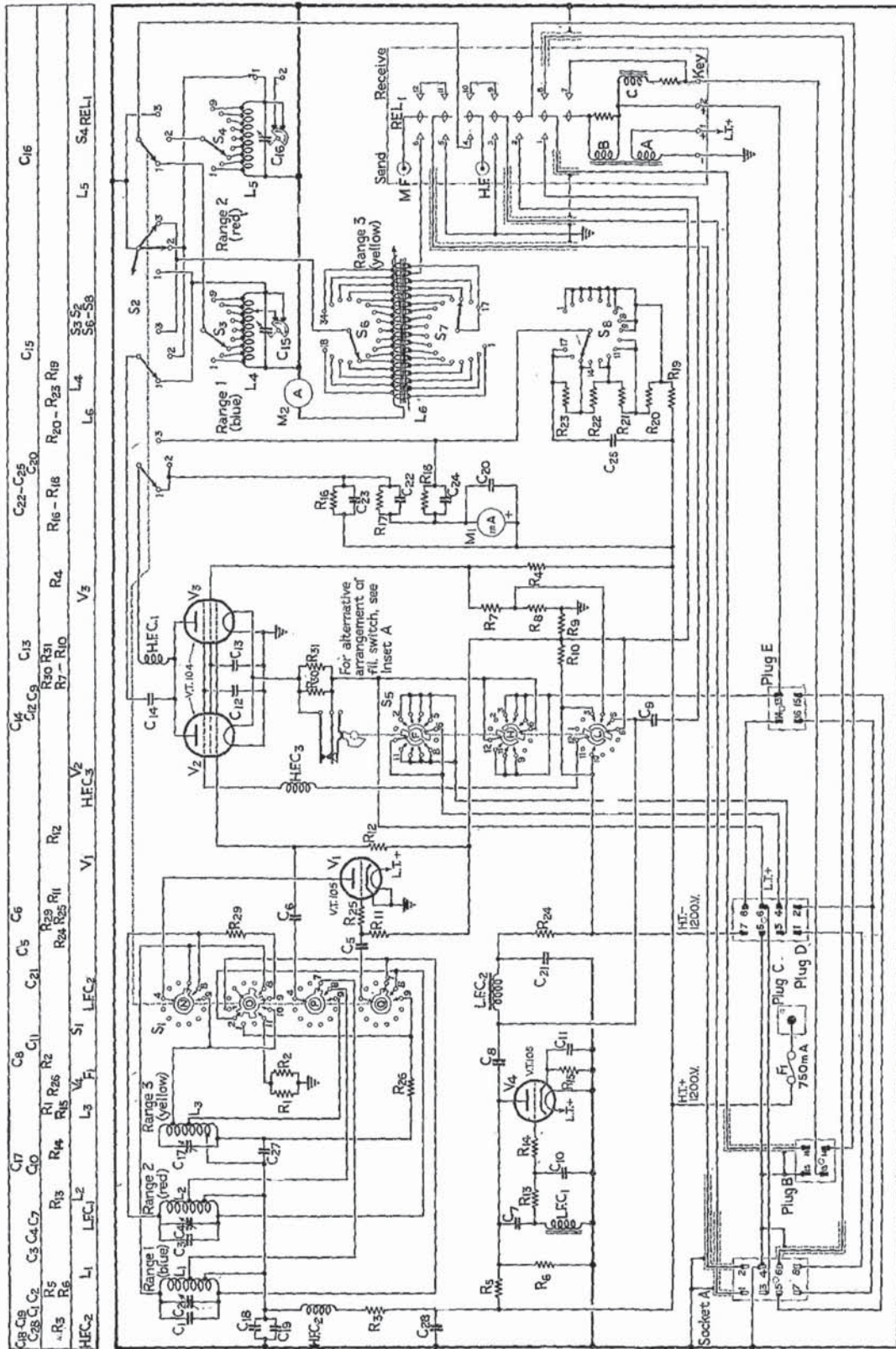
C.W. AND M.C.W. TRANSMITTER COMPONENT LIST

CONDENSERS

Annotation	Value	Type	Stores Ref. No.
C ₁	10 μ F	942	10C/2018
C ₂	11-150 μ F		
C ₃	6 μ F	976	10C/2086
C ₄	11-150 μ F		
C ₅	0002 μ F	943	10C/2038
C ₆	0002 μ F	943	10C/2038
C ₇	50 μ F	944	10C/2039
C ₈	25 μ F	955	10C/2053
C ₉	001 μ F	897 or 1647	10C/965 or 10C/3381
C ₁₀	0002 μ F	946 or 1593	10C/2041 or 10C/3279
C ₁₁	01 μ F	188 or 1503	10C/8496 or 10C/3103
C ₁₂	004 μ F	947	10C/2043
C ₁₃	01 μ F	188 or 1503	10C/8496 or 10C/3103
C ₁₄	004 μ F	948	10C/2043
C ₁₅	7-205 μ F	Part of magnifier unit, type 2 (10D/107)	
C ₁₆	7-205 μ F		
C ₁₇	22.5-379 μ F		
C ₁₈	005 μ F		
C ₁₉	005 μ F	949	10C/2044
C ₂₀	004 μ F	949	10C/2044
		956 or	10C/2055 or
C ₂₁	5 μ F	1502	10C/3102
C ₂₂	0003 μ F	955	10C/2053
C ₂₃	0003 μ F	950 or 1501	{ 10C/2045 or 10C/3101
C ₂₄	0003 μ F		
C ₂₅	001 μ F	1647	10C/3381
C ₂₆	40 μ F	1648	10C/3383
C ₂₇	004 μ F	1505	10C/3105

RESISTANCES

Annotation	Value Ohms	Type	Stores Ref. No.
R ₁ , R ₂	51,000 or 24,000 (1 offs or 27,000 (1 offs	868 or 6119	10C/677 or 10C/6119
R ₃	50,000	1043	10C/1043
R ₄	20,000	1044	10C/1044
R ₅ , R ₆	75,000	1045	10C/1045
R ₇ , R ₈	12,000 + 2,000	1046	10C/1046
R ₉	5,000	1047	10C/1047
R ₁₀	350	1048	10C/1048
R ₁₁	15,000	1049	10C/1049
R ₁₂	20,000	1050	10C/1050
R ₁₃	680	1053	10C/1053
R ₁₄	7,500	1051	10C/1051
R ₁₅	820	1052	10C/1052
R ₁₆ -R ₁₈	10 + 19.5 + 19.5	1056	10C/1056
R ₁₉ -R ₂₃	10 + 2.9 + 5.3 + 12.6 + 69.2	1055	10C/1055
R ₂₄	5,100 or 4,700	942 or 917	10C/877 or 10C/1872
R ₂₅	51	934	10C/851
R ₂₆	510	868	10C/677
R ₂₇ , R ₂₈	10 + 6	1054 or 6833	10C/1054 10C/6833
R ₂₉	150	1931	10C/1931
R ₃₀ and R ₃₁	1.5	8208	10C/8208



Note. S1 and S2 shown in extreme anti-clockwise position. Socket & plugs as viewed from front of transmitter.

FIG. 3

CIRCUIT OF C.W. M.C.W. TRANSMITTER (T1154A & T1154E)

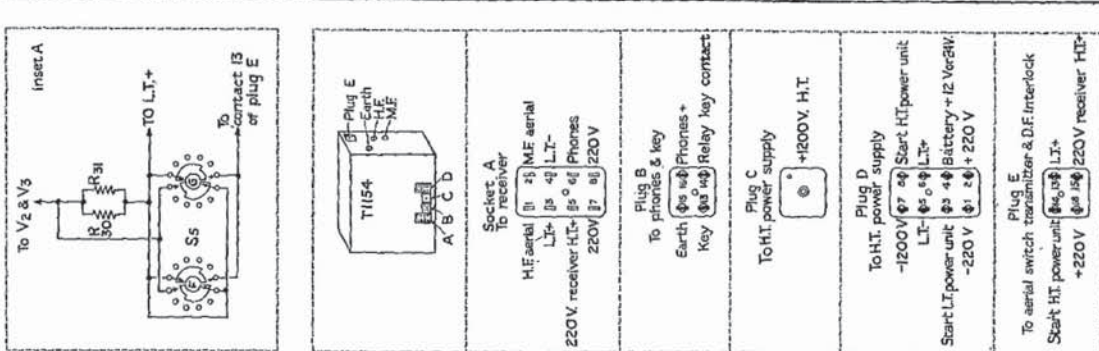


FIG. 3

17. An indirectly-heated triode valve V_4 has a triple function. On C.W. transmission it is used as an A.F. oscillator tone source of approximately 1200 c/s., to provide monitorial side-tone to the telephones as a check upon accurate keying. On M.C.W. transmission the oscillations from V_4 are fed to the negatively-biased suppressor grids of the power amplifiers V_2 and V_3 . The output from V_2 and V_3 is, thus, modulated approximately 70 per cent. at 1200 c/s. and, simultaneously, side tone is provided as in the case of C.W. On R/T transmission the valve V_4 acts as a modulator, variations in its anode voltage, due to speech, being imposed upon the suppressor grids of V_2 and V_3 . Speech side tone is, then, available in the telephones.

C.W. and M.C.W. circuit (T.1154A and T.1154E)

18. For a detailed examination of the circuits of the types providing C.W. and M.C.W. only, reference should be made to the diagram of fig. 3. A simplified switching schematic, fig. 7, should assist in the study of the circuits. It is essential that the switching arrangements should be closely studied and priority has been given in this chapter to a description of the switching. The main and secondary switching components are, so far as is possible, given in their operational sequence. The aerial switching arrangements, represented by the aerial switching unit, type J, or by its alternative, the aerial selector plug board, are, however, dealt with later in the chapter. These instruments are, physically, extraneous to the transmitter proper.

The master switch, S_5

19. A master, or operational switch, controls the power supplies to the transmitter and, in the purely C.W. and M.C.W. versions, has five positions:—OFF, STAND-BI, TUNE, C.W. and M.C.W. These positions control three sections which are referred to in this chapter as L, H and F and annotated as S_{5L} , S_{5H} and S_{5F} .

20. In the OFF position the equipment is completely switched off and both the rotary transformer power units are idle. The transmitter, and the associated receiver, are, therefore, inoperative.

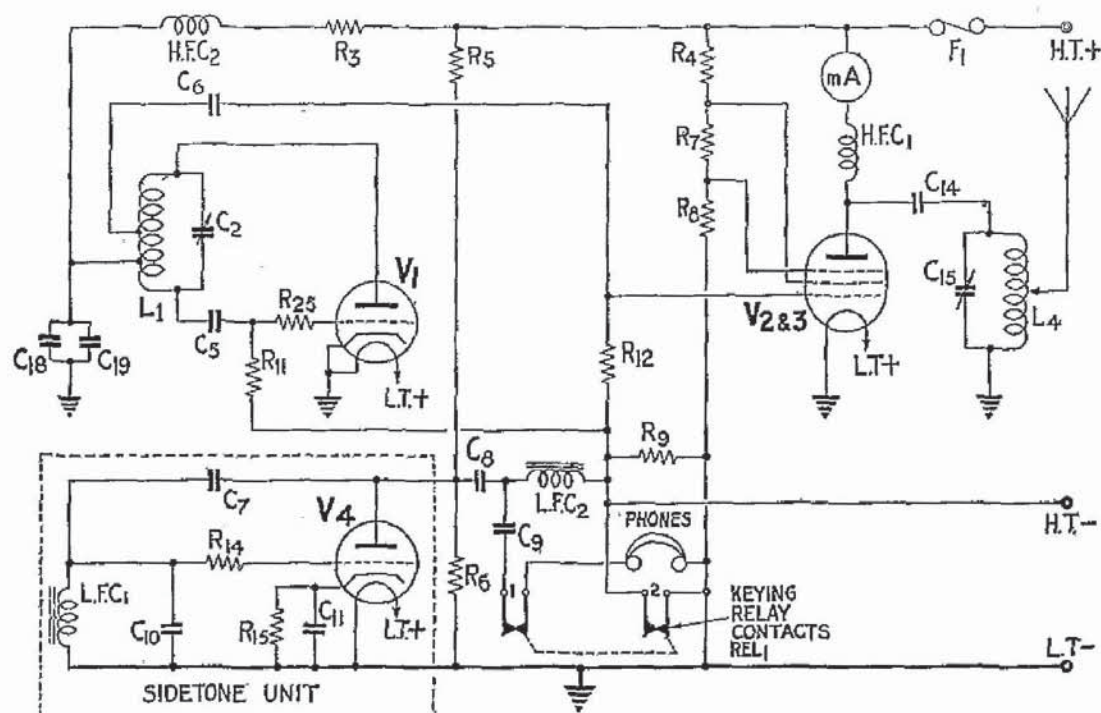


FIG. 4.—SIMPLIFIED CIRCUIT C.W. ON RANGE 1

21. In the STAND-BI position the L.T. power unit, which provides the 6-volt heater supply for the transmitter and receiver (with H.T. to the receiver) is energized through the closing of the circuit at S_{5F} and through points 3 and 4 of an eight-way Jones plug, type D, to the accumulator input circuit of the L.T. power unit, with consequent application of its L.T. output, *via* points 5 and 6 of plug D to a magnetic relay, type 85, which is the SEND-RECEIVE relay REL_1 . This is a multi-contact relay operated from the 6-volt supply. One coil A of the relay is energized and this causes a switching action to the RECEIVE position at which it is held.

22. The 6-volt supply is always made as there is no switching of the heater circuits. In the STAND-BY position, however, two limiting resistances R_{30} and R_{31} are brought into the heater circuit of the power amplifiers V_2 and V_3 and reduce the current whilst the transmitter is inoperative.

23. In the TUNE position of the switch S_5 the energization of the L.T. power unit is maintained, the circuit being completed as before. Through the point 8 of plug D, the interlock plug E, point 14, and the aerial selector switch, type J or aerial plug board, the H.T. power unit is started. This extraneous switching should be in any position with the exception of D/F and EARTH.

24. In the TUNE position, also, the circuits of the remaining two windings B and C of the relay REL_1 are also completed through the key K_1 , connected between the points 13 and 14 of a four-point plug B, so that when the key is pressed, the relay snaps over to the SEND position, completing the H.T. positive circuit through a one-hole plug C, a 750 mA fuse F_1 and, dividing, through:—

- (i) A milliammeter M_1 with its associated circuits, one section of a four-section frequency range switch S_2 and a R.F. choke coil HFC_1 , to the joined anodes of V_2 and V_3 ;
- (ii) the resistance R_3 (see para. 13), a R.F. choke coil HFC_2 which prevents short-circuiting of R.F. through the H.T. supply, and a portion of the appropriate RANGE coil, through a section N of the frequency range switch S_1 to the anode of the oscillator valve V_1 ;
- (iii) a potentiometer R_4 – R_7 and R_8 which maintains the screen voltage of the power amplifier valves V_2 and V_3 at approximately 200 volts;
- (iv) a potentiometer R_5 – R_6 which maintains the anode voltage of the valve V_1 , the side tone, modulator or A.F. oscillator valve (see para. 29) at approximately 200 volts.

25. Grid bias for the P.A. valves is obtained by the voltage drop across the resistances R_9 , R_{10} through which the total H.T. supply passes when the key is up on TUNE, M.C.W. or R/T. When the key is pressed, the relay REL_1 short-circuits the resistance R_9 , the control grids of V_2 and V_3 being connected to earth, grid bias being obtained from the voltage dropped across their grid resistances. The suppressor grids of these valves are, however, connected through the switch section S_{51} to H.T. negative and are thus biased by the voltage across R_{10} . This negative bias is applied to the suppressor grids of V_2 , V_3 to limit the anode feed due to mal-adjustment during the tuning operation. Simultaneously, the grid of the M.O. valve V_1 is keyed to earth through an anti-parasitic resistance R_{25} and the grid leak R_{11} .

26. In the TUNE position of the master switch S_5 the negative biasing of the suppressor grids of the valves V_2 and V_3 puts them in a condition in which low power transmission is possible. Short-distance communications and any setting-up adjustment of the transmitter should be made with S_5 at this position. As an example of the effect obtained, working, for instance, on 10 Mc/s, the anode current would be in the region of 60 mA with an aerial current of 0.25 amp. The suppressor grid voltage is of the order of 45 negative.

27. In the C.W. position of S_5 the L.T. energizing circuits of both power units are maintained so that H.T. and L.T. continue to be supplied to the transmitter and receiver. The suppressor grid is connected through the switch section S_{51} to the junction of resistances R_7 , R_8 , which are part of the potentiometer R_4 , R_7 , R_8 which maintains the screening grids at the correct positive potential. The suppressor grids are therefore also maintained at a positive potential in the C.W. position, increasing the power output. In this position no grid bias is required from R_{10} which is shorted out to prevent loss of H.T. voltage to the valves. For the purpose of comparison with the readings given in para. 26, on 10 Mc/s operation the anode current is of the order of 92 mA, the aerial current, approximately, 0.4 amp. and the suppressor grid voltage, approximately, 20 volts positive with grid current of 7.5 mA. The side-tone circuits remain unaltered at C.W.

28. When the switch S_5 is at M.C.W. position, the short-circuit is removed from R_{10} and a negative bias is again imposed upon the suppressor grids of V_2 and V_3 , and the readings for anode current, aerial current and suppressor grid voltage are closely approximate to those of the TUNE position. The anode current is slightly less but the aerial current is higher, due to the modulation, about 20 per cent. increase should be obtained for 70 per cent. modulation. The suppressor grids of the power amplifiers are connected to H.T. negative through the output load of the A.F. oscillator valve V_4 , which is an A.F. choke LFC_2 .

29. The anode circuit of the valve V_4 is coupled, *via* a condenser C_7 , to the oscillatory circuit constituted by an A.F. choke coil LFC_1 and a condenser C_{10} . This circuit has a frequency of oscillation of 1200 c/s, approximately. The amplitude of the oscillatory current is limited by a resistance R_{13} , an anti-parasitic resistance R_{14} being connected in the grid lead. Grid bias is obtained by the cathode resistance R_{15} which is by-passed by the condenser C_{11} , which is further increased should grid current flow in R_{13} , R_{14} on the peaks of the oscillations.

30. The output from V_4 is developed across R_6 , across which is a resonant circuit composed of the choke coil LFC_2 of maximum inductance value 1.21H (minimum 0.99H), a condenser C_8 and a by-pass condenser C_{21} . To broaden the response sufficiently to accommodate variations of A.F. note between 800 and 1200 c/s a resistance R_{24} is included between LFC_2 and H.T. negative.

31. The A.F. modulating voltages are applied to the suppressor grids of V_2 and V_3 in series with the negative bias. A condenser C_{12} serves to keep the suppressor grids and filaments at the same R.F. potential and C_{13} serves a similar purpose for the screen and filament. In the M.C.W. position the side-tone circuits are unaffected. Whilst V_4 is in an oscillating condition all the time, the side-tone circuit is only made when the key is pressed. The A.F. oscillations are made available through a condenser C_9 , the relay REL_1 , which makes and breaks the telephone circuit, and the points 15 and 16 of a four-pole key and telephone plug B. Through the action of REL_1 , when the key is released, listening through is available.

32. It should be noted that the A.F. oscillatory circuit of the valve V_4 is quite independent of the M.O. circuit which governs the transmission. In consequence, strength or quality of side tone gives no indication of the strength or quality of the emitted signals. The action of the side tone in this transmitter should not be confused with that existing in aircraft installations wherein the side-tone circuits are directly associated with the transmitter output in which case weak transmission results in weak side tone. Both the milliammeter M_1 and the aerial ammeter M_2 (on RANGE 3) or the external ammeter (on RANGES 1 and 2) should deflect during transmission. If the receiver is tuned to the transmission frequency its tuning indicator ("magic eye") will flicker to the dots and dashes. Rough indications of transmission are, thus, available.

The frequency range switch (S_1 and S_2)

33. A frequency range switch, consisting of two ganged switches S_1 and S_2 , is included in the circuit, its function being to accomplish all the necessary circuit changes associated with the three frequency RANGES. The switch S_1 has four sections or sets of contacts which are lettered N, O, P and Q. These contacts effect all necessary M.O. circuit changes as described in ensuing paragraphs.

34. Each of the three frequency RANGES has its own coil and tuning condenser as indicated in the accompanying TABLE A.

TABLE A
M.O. COILS AND CONDENSERS

Range	Frequency	Coil	Inductance	CONDENSERS			
				Variable	Capacitance	Fixed	Capacitance
1. BLUE	10-5.5 Mc/s	L_1	5.32 μ H	C_2	11-150 μ F	C_1	10 μ F
2. RED	5.5-3.0 Mc/s	L_2	17.27 μ H	C_4	11-150 μ F	C_3	6 μ F
3. YELLOW	500-200 kc/s	L_3	2285 μ H End to Tap 1 1925 μ H End to Tap 2 1220 μ H End to Tap 3 590 μ H	C_{17}	22.5-379 μ F	C_{27}	40 μ F

35. In the circuit for the RANGE 1, the coil L_1 with its tuning condenser C_2 and the parallel fixed condenser C_1 are connected, through the sections N and Q of S_1 , across the anode and grid of the M.O. indirectly-heated triode valve V_1 . A condenser C_5 and an anti-parasitic resistance R_{25} complete the circuit of L_1 to the grid of the valve V_1 . The grid-leak resistance for the stage is R_{11} and this leads to earth through either the resistance R_9 or, directly, via the keying contacts of REL_1 when S_5 is at TUNE (see para. 25). The section P of the switch S_1 couples the coil L_1 to the control grids of the parallel connected power-amplifier pentodes V_2 and V_3 through a condenser C_6 . The section O of the switch S_1 short-circuits the RANGE 2 coil L_2 .

36. In the circuit of RANGE 2, the coil L_3 is tuned by the variable condenser C_4 having the fixed condenser C_3 in parallel. The tuned circuit is connected to the valve V_1 by the sections N and Q of the switch S_1 . The section P of S_1 couples the coil L_2 to the amplifier valves V_2 and V_3 through the condenser C_6 . The section O of S_1 short-circuits the coil L_1 of RANGE 1. The circuit associated with RANGE 3 consists of the coil L_3 tuned by the variable condenser C_{17} and connected by the sections N and Q of the switch S_1 and a resistance R_{26} to the valve V_1 . The section P couples the coil L_3 through the condenser C_6 to the valves V_2 and V_3 . The section O of S_1 short-circuits the RANGE 2 coil L_2 .

37. The M.O. stage has essentially a higher efficiency factor when used for the band of frequencies covered by RANGE 3 (M.F.) than when employed for the frequencies of either RANGE 1 or RANGE 2. It is therefore necessary to incorporate some limiting arrangement in the nature of a bank of resistances R_1 and R_2 between the H.T. positive line and earth. These resistances are brought into circuit *via* the section O of the switch S_1 and the coil L_7 . They act as a parallel H.T. load and so limit the voltage rise. A resistance R_{28} prevents the generation of parasitic oscillations which might also occur in this range. The capacitance of a $40 \mu\mu\text{F}$ condenser C_{27} is also included between the H.T. feed tapping point of L_3 and the grid end of that coil.

38. The section S_3 of the frequency range switch combination consists of four sets of contacts, and these accomplish all the necessary circuit changes between the output of the power amplifier valves V_2 and V_3 and the aerial circuits when switching from one RANGE to another.

39. In the circuits of the RANGES 1 and 2, the positive H.T. supply is fed through a milliammeter M_1 across a section of the switch S_2 , and a R.F. choke coil HFC_1 to the anodes of the parallel amplifier pentodes V_2 and V_3 . The milliammeter is calibrated on these ranges by R_{16} and R_{17} , which are disconnected on RANGE 3, when the resistance combination R_{18} to R_{23} shunt the meter so that on the different frequencies of this range, the same apparent anode current is obtained when actually this is limited to suit the frequency in use (*see* para. 44).

40. The anode load impedance of V_2 V_3 is coupled by the condenser C_{14} and a section of the switch S_2 . In the RANGE 1 position a tapped coil L_4 is tuned by a variable condenser C_{15} which is fitted with a commutator device which enables the inductance of the coil L_4 to be varied. This additional facility enables a greatly increased tuning range to be achieved, affording a wide margin for coupling to the differing aerial systems. The aerial is connected across the keying relay REL_1 and the switch S_2 to a switch S_3 by which the tapings on the coil L_4 are selected. A tuning coil L_5 of RANGE 2 is short-circuited and earthed by the action of the switch S_3 . An external aerial ammeter is provided to give an *approximate* indication of radiation at the transmitted frequencies.

41. In the circuit of RANGE 2 the H.T. positive is supplied *via* the milliammeter M_1 through a section of the switch S_2 and the R.F. choke HFC_1 to the anodes of the valves V_2 and V_3 . The output from the anodes of V_2 and V_3 is coupled through a condenser C_{14} to the RANGE 2 tuning coil L_5 and a section of the switch S_2 . The coil L_5 is tuned by a condenser C_{16} which is fitted with a commutator device similar to that of C_{15} . The aerial is connected across the keying relay REL_1 and the switch S_2 to a switch S_4 which selects the appropriate tapings on the coil L_5 . Any portion of a tuning coil L_6 , which is the RANGE 3 coil, brought into circuit by the tapping switch, is earthed by the action of S_2 . An external ammeter is in circuit as for RANGE 1.

42. In the position of RANGE 3 the aerial forms the tank circuit capacitance, tuned by the tapped coil L_6 . Coarse tuning is provided by the switch S_7 which shunts out the portion of the coil not in use. Fine tuning is obtained by the permeability method, a sliding dust iron core being adjusted inside the coil L_6 . The valve impedance is matched to the aerial by means of a switch S_8 which adjusts the point at which the anodes of V_2 V_3 are tapped on to the aerial coil. Ganged to S_7 is the switch contact S_9 which varies the resistances in shunt with the milliammeter M_1 .

43. The Q value of the total inductance of L_6 is a minimum of 225 at 200 kc/s and the R.F. resistance of the coil is 12 ohms. The accompanying TABLE B shows the approximate inductance between the tapping points of the coil.

TABLE B
RANGE 3—OUTPUT CIRCUIT COIL TAPPINGS

Tap No.	Inductance μH	Aerial Tap	Anode Tap
1	38	—	1
2	46	—	2
3	59	—	3
4	70	—	4

Note:—To be read in conjunction with fig.  5

C.W. M.C.W. AND R/T TRANSMITTER

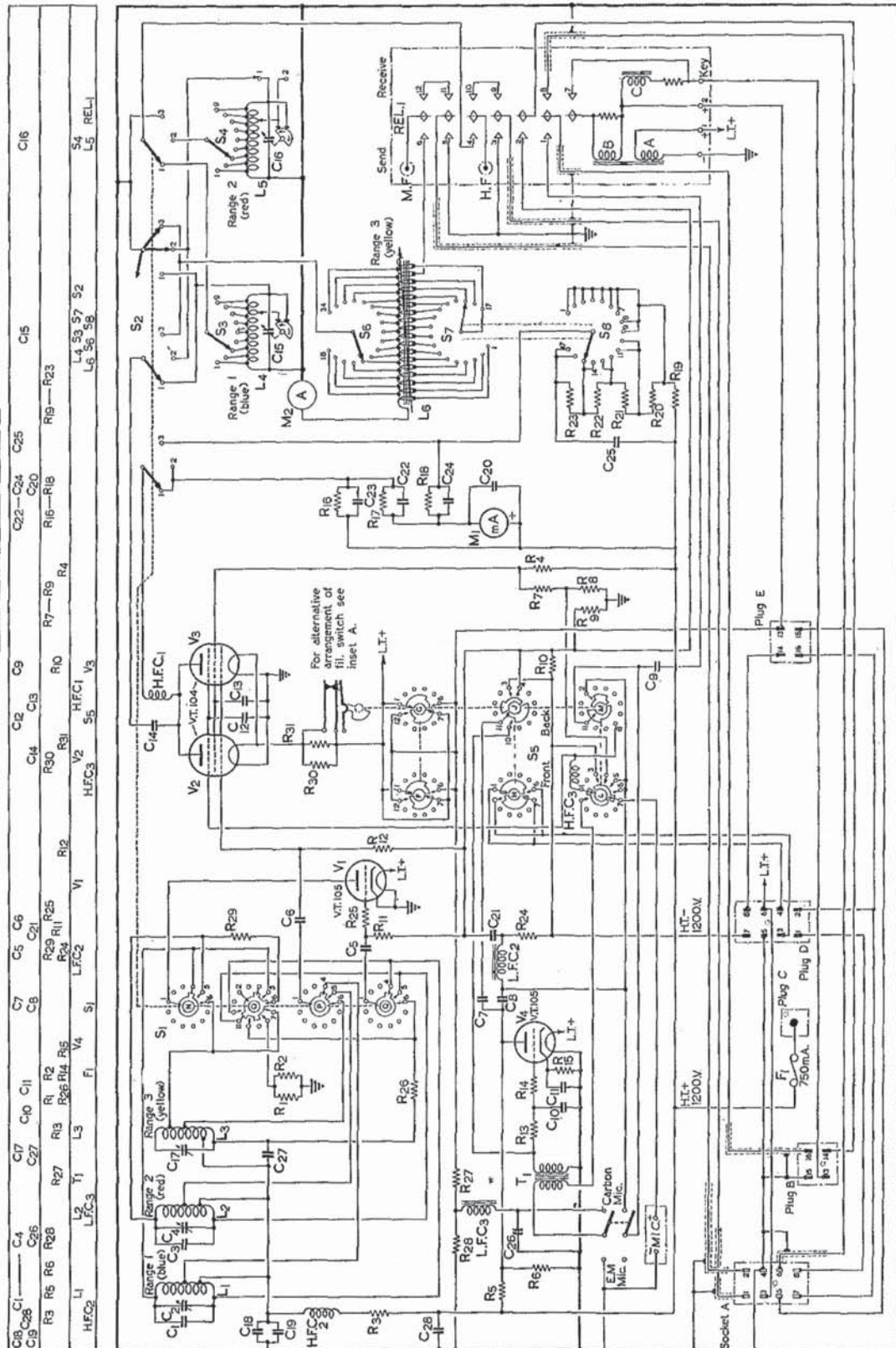
COMPONENT LIST

CONDENSERS

Annotation	Value	Type	Stores Ref. No.
C ₁	10 μ F	942	10C/2018
C ₂	11-150 μ F		
C ₃	6 μ F	976	10C/2086
C ₄	11-150 μ F		
C ₅	0.002 μ F	943	10C/2038
C ₆	0.002 μ F	943	10C/2038
C ₇	50 μ F	944	10C/2039
C ₈	25 μ F	955	10C/2053
C ₉	0.01 μ F	897 or	10C/965 or
		1647	10C/3381
C ₁₀	0.002 μ F	946 or	10C/2041 or
		1593	10C/3279
C ₁₁	0.1 μ F	188 or	10C/8496 or
		1503	10C/3103
C ₁₂	0.04 μ F	947	10C/2043
C ₁₃	0.1 μ F	188 or	10C/8496 or
		1503	10C/3103
C ₁₄	0.04 μ F	948	10C/2043
C ₁₅	7-205 μ F	Part of magnifier unit, type 2 (10D/107)	
C ₁₆	7-205 μ F		
C ₁₇	22.5-379 μ F		
C ₁₈	0.005 μ F	949	10C/2044
C ₁₉	0.005 μ F	949	10C/2044
C ₂₀	0.04 μ F	956 or	10C/2055 or
		1502	10C/3102
C ₂₁	5 μ F	955	10C/2053
C ₂₂	0.003 μ F	950 or	10C/2045 or
C ₂₃	0.003 μ F		
C ₂₄	0.003 μ F		
C ₂₅	0.01 μ F	1647	10C/3381
C ₂₆	2 μ F	1031	10C/2220
C ₂₇	40 μ F	1648	10C/3383
C ₂₈	0.04 μ F	1505	10C/3105

RESISTANCES

Annotation	Value Ohms	Type	Stores Ref. No.
R ₁ , R ₂	51,000 or 24,000 (1 offs or 27,000 (1 offs	868 or 6119	10C/677 or 10C/6119
R ₃	50,000	1043	10C/1043
R ₄	20,000	1044	10C/1044
R ₅ , R ₆	75,000	1045	10C/1045
R ₇ , R ₈	12,000 + 2,000	1046	10C/1046
R ₉	5,000	1047	10C/1047
R ₁₀	350	1048	10C/1048
R ₁₁	15,000	1049	10C/1049
R ₁₂	20,000	1050	10C/1050
R ₁₃	680	1053	10C/1053
R ₁₄	7,500	1051	10C/1051
R ₁₅	820	1052	10C/1052
R ₁₆ -R ₁₈	10 + 19.5 + 19.5	1056	10C/1056
R ₁₉ -R ₂₃	10 + 2.9 + 5.3 + 12.6 + 69.2	1055	10C/1055
R ₂₄	5,100 or 4,700	942 or 917	10C/877 or 10C/1872
R ₂₅	51	934	10C/851
R ₂₆	510	868	10C/677
R ₂₇ , R ₂₈	10 + 6	1054 or	10C/1054
		6833	10C/6833
R ₂₉	150	1931	10C/1931
R ₃₀ and R ₃₁	1.5	8208	10C/8208



Note. S1 and S5 shown in extreme anti-clockwise position. Socket & plugs as viewed from front of transmitter.

CIRCUIT OF RT. C.W. AND M.C.W. TRANSMITTER (T.1154, T.1154.B & T.1154.D)

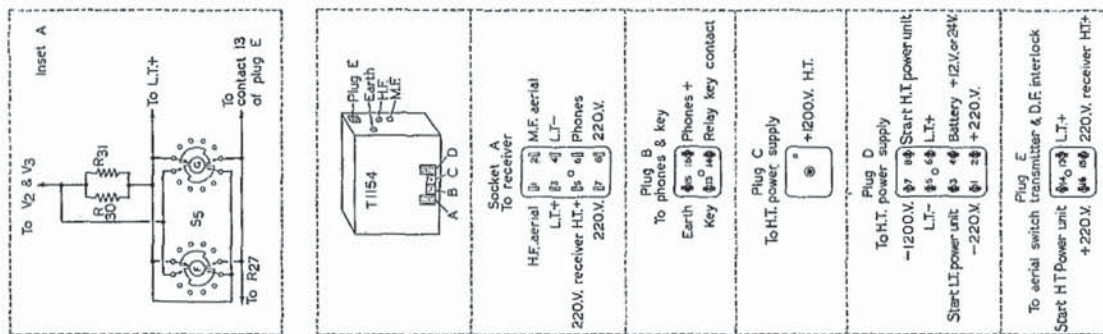


FIG. 5

TABLE B—Sheet 2

Tap No.	Inductance μH	Aerial Tap	Anode Tap
5	82	—	5
6	96	—	6
7	107	—	7
8	122	—	8
9	130	1	—
10	142	—	9
11	147	2	—
12	165	3	—
13	166	—	10
14	180	—	11
15	187	4	—
16	195	—	12
17	208	5	—
18	212	—	13
19	228	6	—
20	232	—	14
21	272	7	—
22	340	8	—
23	345	—	15
24	382	9	—
25	482	—	16
26	486	10	—
27	638	—	17
28	642	11	—
29	700	12	—
30	812	13	—
31	975	14	—
32	1,175	15	—
33	1,562	16	—
34	1,985	Aerial connexion	—
35	1,990	17	—

44. The switch S_3 places a varying value of shunt resistance in circuit with the feed milliammeter M_1 . The resistances R_{13} to R_{23} therefore constitute a tapped potentiometer and the effect is to increase the sensitivity of the milliammeter with an increase in aerial tapping. This provides an indirect means for limiting the voltage to the aerial circuit for, as the aerial inductance is increased progressively higher, values of shunt resistance are corrected across M_1 . Loading can, by this visual indication, be adjusted by keeping the meter reading at a given indication on the scale. The R.F. thermo-ammeter M_2 reading from 0 to 3.5 amp. is connected in the earthed end of the coil L_6 . This meter is used for the M.F. RANGE only and serves to indicate that the transmitter is radiating. An external aerial ammeter is provided for the H.F. RANGES.

45. The effect of the anode feed meter shunt resistances R_{13} to R_{23} is shown by the following details. On RANGES 1 and 2 full scale deflection on the meter M_1 represents from 0–300 mA; on RANGE 3, with switch contacts B and B_1 closed (aerial tapping switch positions 1 to 9), 0–300 mA; contacts A and A_1 closed (taps 10–11), 0–255 mA; contacts A and A_2 closed (taps 12–13) 0–210 mA; contacts A and A_3 closed (taps 14–15), 0–165 mA and with contacts A and A_4 closed (taps 16–17), 0–120 mA.

Filament resistance unit

46. At STAND-BY, the output from the L.T. power unit rises, and would cause failure of the filaments of the VT104 valves, were not two resistances R_{30} R_{31} included in the filament circuit of these valves to reduce this voltage. These resistances were not included in the earlier versions of the transmitter. Instructions have been issued, in leaflet form, for the necessary modification to incorporate these resistances. This modification necessitated the disconnection of a lead between point 6 of plug D from the positive heater pin of the power amplifier, and its reconnection to the switch S_5 and the incorporation of the two parallel resistances.

Transmitters with R/T facilities

47. A complete circuit diagram, in fig. 5, shows the transmitter circuit incorporating R/T facilities. Carbon-granule type microphones are used normally and if it is desired to modulate by the use of the electro-magnetic type, a suitable sub-modulator, such as the A.1134, is connected. The basic transmission circuit is unchanged.

48. Dealing, in the first instance, with the master switch S_5 , this now consists of six sections lettered F, G, H, J, L, and M and annotated, for the purposes of this chapter, as S_{5f} to S_{5m} . When a carbon type microphone is used it is connected, in the R.T. position of S_{5f} , in series with the primary winding of a 25 : 1 ratio microphone transformer T_1 , an audio frequency choke LFC_3 and a resistance R_{28} which is part of a potentiometer R_{27} and R_{28} , across the L.T. supply and gives 2 volts across the microphone. The potentiometer and R_{28} form, in effect, one 16-ohm resistance tapped to form two sections of 10 and 6 ohms. In the case of electro-magnetic microphones the output of the pre-amplifier (A.1134 or suitable instrument) is connected across the primary of T_1 . In both cases the modulating voltage is applied through resistances R_{13} and R_{17} to the grid of V_4 and, to the suppressor grids of V_2 and V_3 , through C_8 , S_{5l} and HFC_3 .

49. For A.F. oscillating purposes the coupling, between the grid and anode of the modulator valve, which went direct to the choke LFC_1 of the purely C.W. and M.C.W. version, is now connected to switch section S_{5j} . It will be appreciated that, in this version of the transmitter, the function of the choke LFC_1 is covered by the transformer, T_1 , secondary winding. In the additional (R/T) position of the switch S_5 the coupling between grid and anode *via* C_7 is removed and the valve V_4 is used as a modulator.

50. At R/T the resistance R_{10} (see para. 28) remains in circuit thus negatively biasing the suppressor grids of V_2 and V_3 . The key K_1 and a switch connected in parallel with it, remain in circuit. To transmit speech, therefore, it is necessary to press the key or operate the switch which is situated conveniently for the pilot. The resistance R_9 is short-circuited through the relay REL_1 . After speech transmission it is necessary to release the key or to put the parallel switch to OFF in order to receive. This action releases the relay REL_1 which moves over to RECEIVE.

Modulation

51. The utilization of suppressor grid modulation implies Class C operation in the output, or power amplifier stage, that is, a biasing of beyond cut-off. This brings about a reduction in the output power of V_2 and V_3 to a value which is, approximately, one third of the power obtained with C.W. and half that which needs to be developed at the time of complete modulation. The anode peak voltage does not exceed the value obtained during C.W. working and, in consequence, there is a safety factor which permits a much higher anode voltage to be used. On the modulation peaks the negatively-biased suppressor grids swing positive and at this time suppressor-grid current flows. The power required to drive this current is furnished by the valve V_4 .

52. Typical figures for R/T transmission at 10 Mc/s are total input current 135 mA, anode current 60 mA, and aerial current 0.45 amp. The modulation should not exceed 70 per cent. At the lowest frequencies, where the power is automatically reduced, the suppressor grid bias is reduced with the lower feed current. High percentage modulation cannot, as a consequence, be obtained.

The magnetic relay, type 85

53. The magnetic relay, type 85, referred to in this chapter as REL_1 , is a multi-contact relay operated by the 6-volt radio supply and is common to all versions of the transmitter. When the key K_1 is depressed, the relay energizing coil circuits are completed thus breaking all necessary receiver circuits and completing all necessary transmitter circuits. The relay therefore performs the functions of a send-receive switch operated by the morse key K_1 . In the intervals of keying, the receiver becomes operative for "listening through". The relay REL_1 can operate at a speed which is the equivalent of more than 25 words per minute.

54. The relay REL_1 incorporates three coils A, B and C. The coil A is in circuit so long as the transmitter is switched on, that is, with the master-switch S_5 at any of the positions STAND-BI, TUNE, C.W., M.C.W. or R/T. With S_5 in the STAND-BI position the coil A only is energized and holds the relay in the RECEIVE position. The key K_1 is not in circuit.

55. When the switch S_5 is in the TUNE, C.W., M.C.W., or R/T position the key K_1 is switched into circuit. Depression of K_1 energizes both B and C coils of REL_1 , the connexion of the winding B being so arranged that its field neutralises the field due to the holding coil A. The resistance and the inductance of the coil B is made very small in order to effect the demagnetizing process very rapidly. Were the circuit to remain closed for any length of time, undue high current dissipation would result in the coil B and, in consequence, this coil B is energized through an auxiliary pair of contacts on the relay only long enough for coil C to operate.

56. A rapid rise of current through the coil B ensues when K_1 is pressed. At the instant when the net field resulting from both coil A and coil B is zero the relay commences to move under the combined action of the spring contacts. The auxiliary relay contacts open, thus cutting off the current through the coil B. This sudden cessation of current in coil B causes a transient condition in the coil A which instantly reduces its current to zero. Thereafter the field of the coil A is re-established at a rate determined by the high inductance of this winding. In effect, the coil B demagnetises the holding or RECEIVE magnet (coil A).

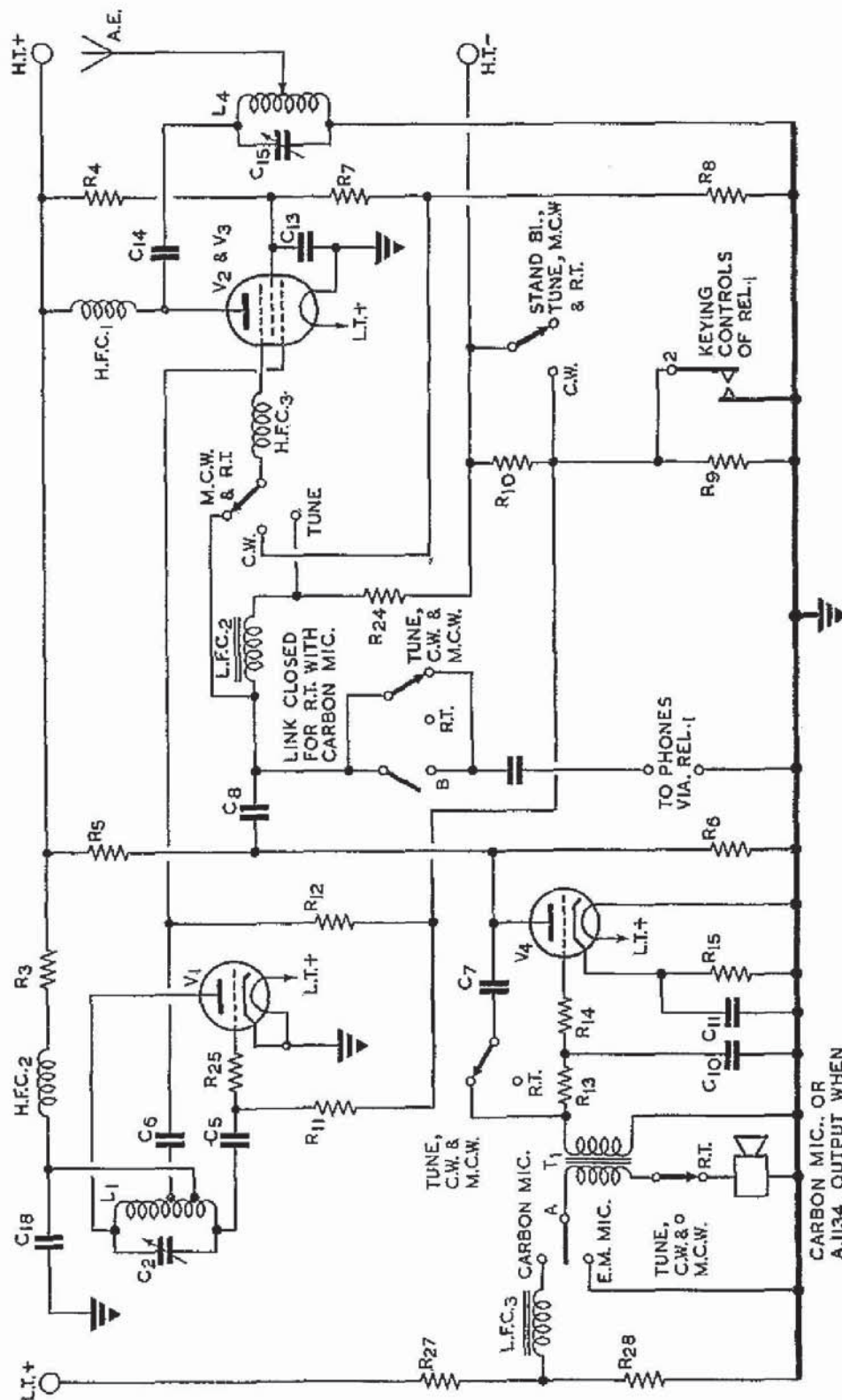


FIG. 6.—SIMPLIFIED CIRCUIT, SWITCHING IN RANGE 1

57. Although the demagnetizing coil is then disconnected, the field due to the coil A is not fully re-established until after a period of time considerably longer than the transit time of the relay. As the energizing of the coil C takes place simultaneously with that of the coil B, that is when K_1 is pressed, it follows that the relay motion by coil B will be completed by the attraction due to the coil C.

58. The re-establishment of the field of the coil A does not sensibly affect the hold-on power of the coil C due to the variation in air gap of the two coils. When K_1 is released the relay must rapidly return to the RECEIVE position, since the field of the coil A is already established, and the field due to the coil C will collapse immediately the current is cut-off by the breaking of the key circuit.

59. The functions performed by the various contacts of REL_1 may be summarized as follows:—

- (i) The two aërials, fixed and trailing, are switched from the transmitter to the receiver.
- (ii) In the transmit position the receiver aerial leads are earthed.
- (iii) The telephones are switched from the receiver to the transmitter.
- (iv) The keying circuit proper is made on the TRANSMIT side.
- (v) An auxiliary contact is provided which is associated with the relay coil B circuit.

Listening-through

60. Although the STAND-BY position is provided on the master switch S_6 for RECEIVE, it is not necessary to operate this switch during a series of transmissions. This position is provided so that if it is probable that no transmission will be made for some time, the H.T. power unit can be switched OFF and so reduce the drain on the aircraft general electrical system. When the switch is placed to TUNE, C.W., M.C.W. or R/T, the transmitter H.T. power unit is started up, but the equipment is still in a state of RECEIVE until the key K_1 is pressed. The operator can transmit and receive messages without any operations other than sending his message on the key. Whilst sending a message the receiver is operative when the key is raised. The distant station can, thus, call the operator's attention during his transmission if required.

Transmitter T.1154C

61. A complete circuit diagram of the transmitter T.1154C is shown in fig. 8. The basic circuit is similar to that already described. Four bands are, however, provided as given in para. 2, and the upper frequency limit, accordingly, becomes 16.7 Mc/s as compared with 10 Mc/s of the transmitters already dealt with in this chapter. To provide for the additional H.F. BLUE RANGE circuits the frequency range switch S_2 , which is ganged to the master switch S_5 , has been changed. Both RANGES 1 and 2 are obtained on the same oscillator and output controls.

62. The RANGES 1 and 2 (BLUE) oscillator coil has an inductance of 8.52 μH . The RANGE 3 (RED) coil is 28.7 μH . The RANGE 4 (YELLOW) has a total inductance 2266 μH with, from end of winding to tap 1, 1925 μH , from end to tap 2, 1212 μH and from end to tap 3, 590 μH .

63. Between the output circuit coil for RANGE 3 and earth a three-point reversible socket X-N is interpolated. Its purpose is to enable highly resistive or reactive aërials to be satisfactorily loaded. The normal position of the socket is with the arrow (on the panel) pointing to N. In the reverse position a condenser of 0.0003 μF (that is $C_{30} + C_{31}$) is connected between the aerial end of the circuit to earth.

64. On RANGE 3 (RED) the variable condenser C_{16} operates a switch through a cam on the condenser spindle. This switch is connected in series with the relay REL_1 and serves to back bias the transmitter H.T. at a point where the commutator switch makes or breaks. This prevents arcing at the commutator switch contacts α and β shown in fig. 8. A pair of contacts ganged with the frequency range switch S_1 opens on RANGE 4 but is closed on the other ranges. This prevents absorption effects by the RANGE 4 coil in certain frequencies.

Transmitters T.1154D and T.1154E

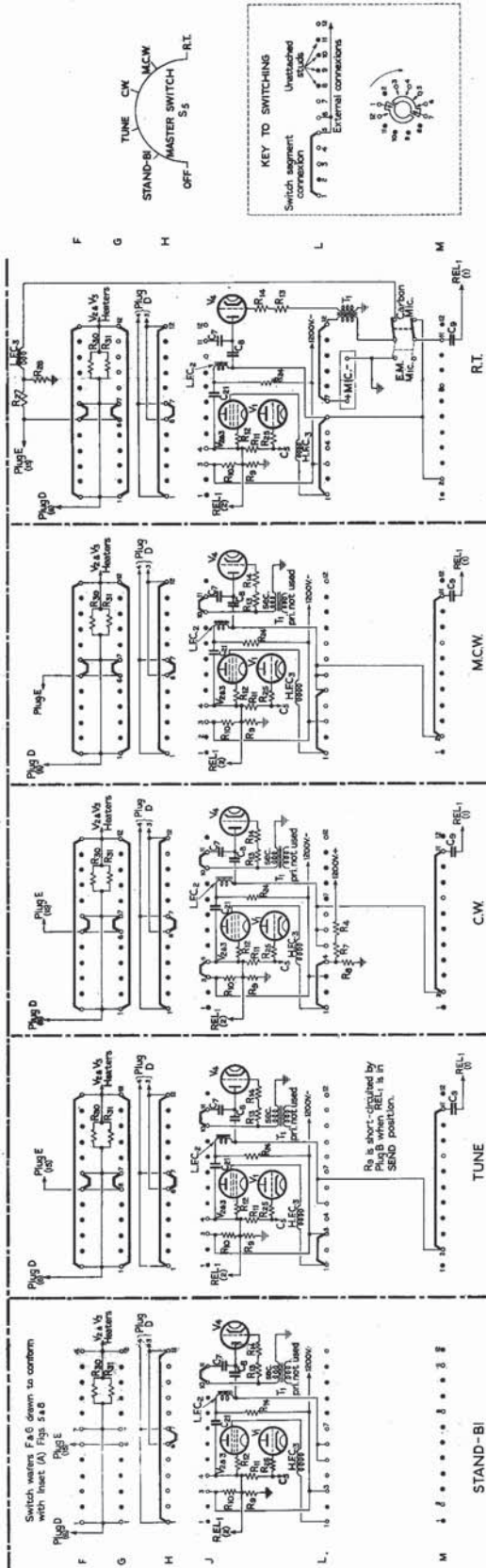
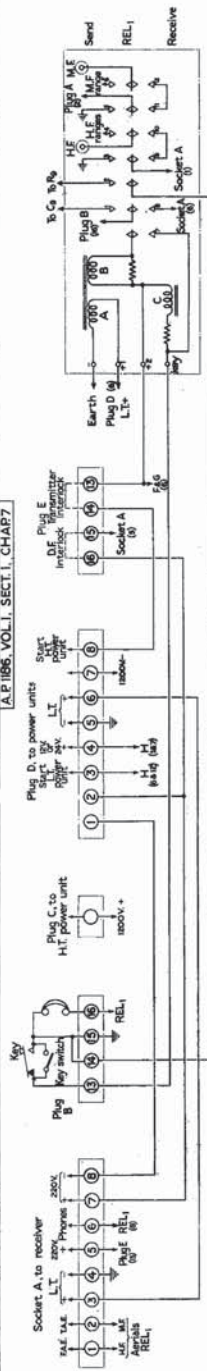
65. The transmitters T.1154D (R/T, C.W. and M.C.W.) and T.1154E (C.W. and M.C.W.) differ from the T.1154 and T.1154A only in respect of the modified frequency coverage on RANGES 1 and 2 and in the matter of application. They are used in multiple-channel transmitter mobile ground stations and are supplied with power from single-phase, 50 c/s mains through a power unit. As the transmitters are not interlocked with a receiver as in airborne practice, arrangements are made whereby the relay REL_1 is held permanently to TRANSMIT.

66. The output from these transmitters is worked into either local or remote aerial systems. The remote system consists of a $\frac{\lambda}{4}$ inclined vertical aerial. The local system is, normally, a triatic supported array the arrangement of which provides for anchoring eight possible aërials. This mobile system will, ultimately, be described elsewhere in this publication.



FIG. 7

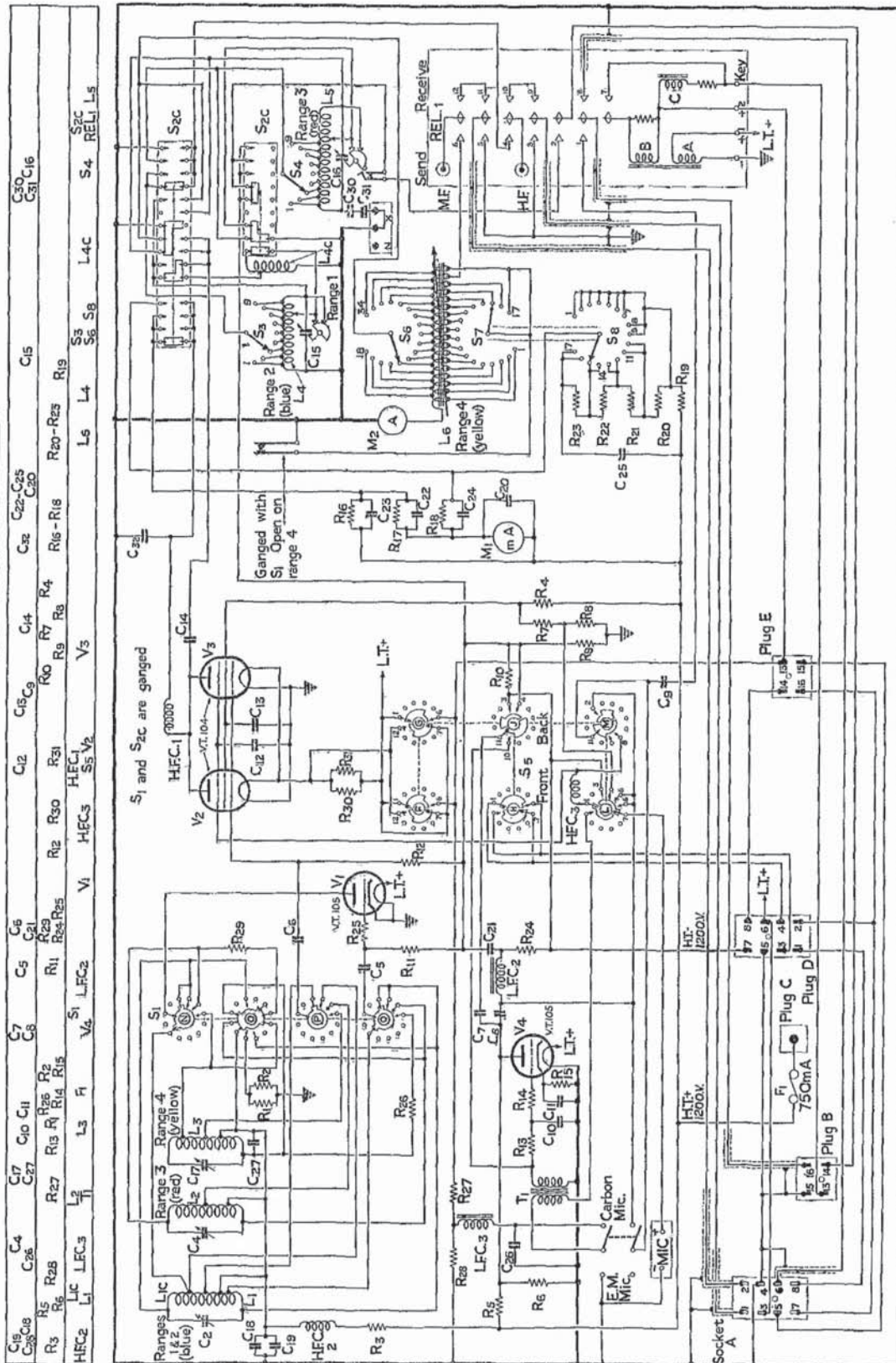
NOTE
THIS DIAGRAM SHOWS THE CIRCUIT
CONDITION AS IMPOSED BY EACH
WAFFER AT EACH POSITION OF THE
MASTER SWITCH S5.



SCHEMATIC OF SWITCHING ARRANGEMENTS (RT VERSION)

FIG. 7a

FIG. 7a



Note: S1 and S5 shown in extreme anti-clockwise position. Socket & plugs as viewed from front of transmitter.

CIRCUIT OF T.1154C

FIG. 8

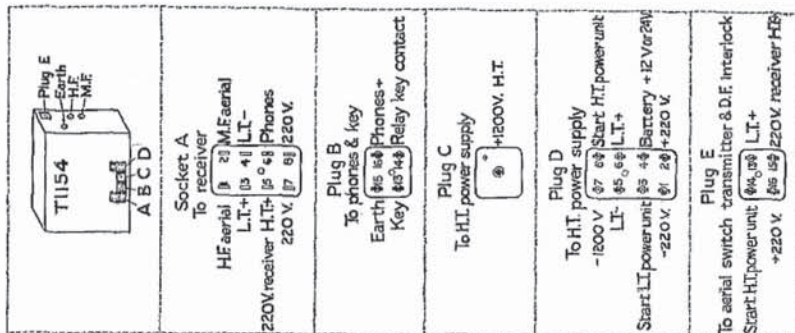
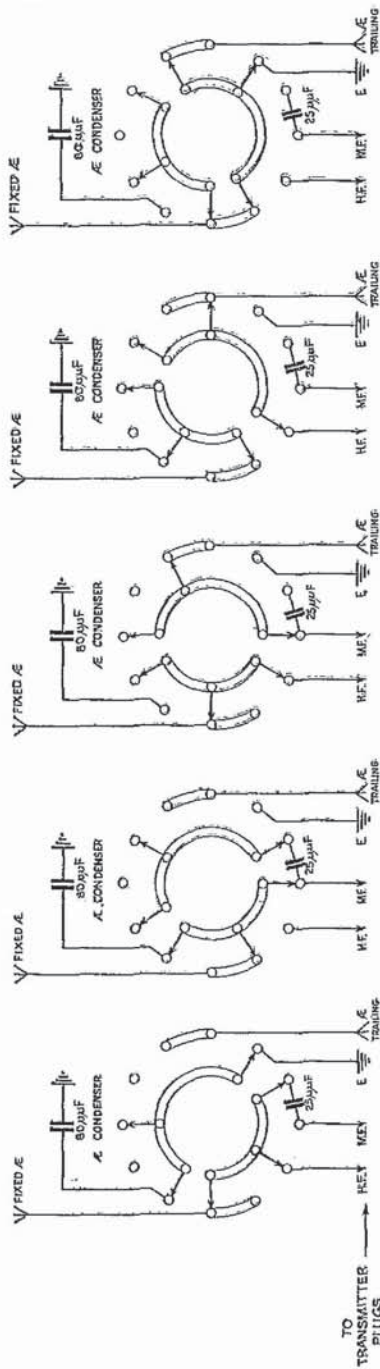
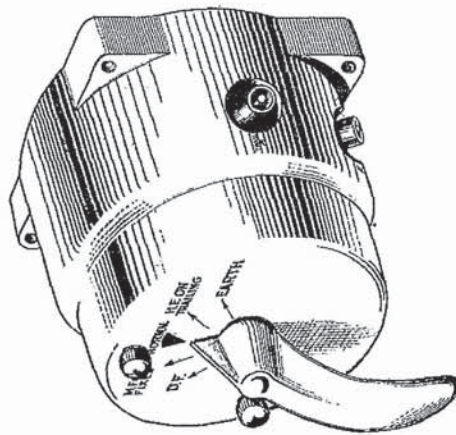
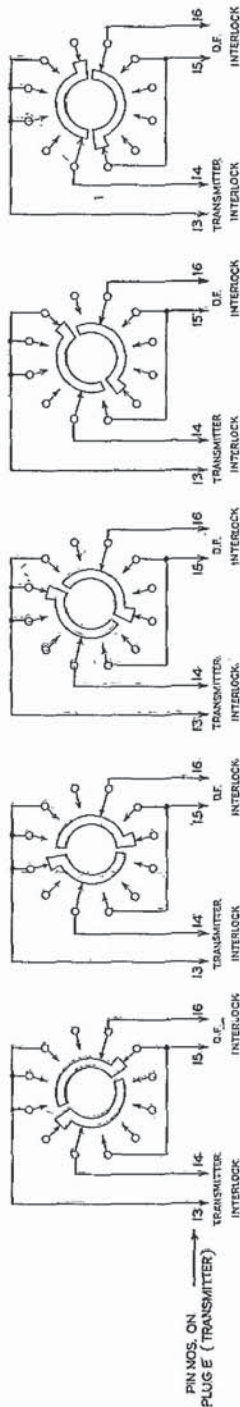


FIG. 8



POSITION OF MAIN SWITCH



AERIAL SWITCHING UNIT Type J
THEORETICAL CONNEXIONS

POSITION OF AUXILIARY SWITCH GANGED TO MAIN SWITCH

D.F. POSITION 1	M.F. ON FIXED POSITION 2	NORMAL POSITION 3	H.F. ON TRAILING POSITION 4	EARTH POSITION 5
MAIN SWITCH	MAIN SWITCH	MAIN SWITCH	MAIN SWITCH	MAIN SWITCH
FIXED A.E. TO H.F. & M.F.	FIXED A.E. TO M.F. & A.E. LOADING CONDENSER	FIXED A.E. TO H.F. TRAILING A.E. TO M.F.	TRAILING A.E. TO H.F.	FIXED & TRAILING A.E.'S TO EARTH
AUXILIARY SWITCH	AUXILIARY SWITCH	AUXILIARY SWITCH	AUXILIARY SWITCH	AUXILIARY SWITCH
TRANSMITTER INTERLOCK OPEN CIRCUIT	TRANSMITTER INTERLOCK CLOSED CIRCUIT	TRANSMITTER INTERLOCK. CLOSED CIRCUIT	TRANSMITTER INTERLOCK OPEN CIRCUIT	TRANSMITTER INTERLOCK OPEN CIRCUIT
D.F. INTERLOCK CLOSED CIRCUIT	D.F. INTERLOCK OPEN CIRCUIT	D.F. INTERLOCK OPEN CIRCUIT	D.F. INTERLOCK OPEN CIRCUIT	D.F. INTERLOCK CLOSED CIRCUIT

Note:—To be read in conjunction with fig. 8

TRANSMITTER T.1154C

COMPONENT LIST

CONDENSERS			
Annotation	Value	Type	Stores Ref. No.
C ₂	11-150 μ F		
C ₄	11-150 μ F		
C ₅	.0002 μ F	943	10C/2038
C ₆	.0002 μ F	943	10C/2038
C ₇	50 μ F	944	10C/2039
C ₈	.25 μ F	955	10C/2053
C ₉	.001 μ F	897 or 1647	10C/965 or 10C/3381
C ₁₀	.0002 μ F	946 or 1593	10C/2041 or 10C/3279
C ₁₁	.01 μ F	188 or 1503	10C/8496 or 10C/3103
C ₁₃	.004 μ F	947	10C/2043
C ₁₃	.01 μ F	188 or 1503	10C/8496 or 10C/3103
C ₁₄	.004 μ F	948	10C/2043
C ₁₅	7-205 μ F	Part of magnifier unit, type 3 (10D/107)	
C ₁₆	7-205 μ F		
C ₁₇	22.5-379 μ F		
C ₁₈	.005 μ F		
C ₁₉	.005 μ F	949	10C/2044
C ₂₀	.004 μ F	949	10C/2044
C ₂₁	.5 μ F	956 or 1502	10C/2055 or 10C/3102
C ₂₂	.0003 μ F	955	10C/2053
C ₂₃	.0003 μ F	950 or 1501	{ 10C/2045 or 10C/3101
C ₂₄	.0003 μ F		
C ₂₅	.001 μ F	1647	10C/3381
C ₂₆	2 μ F	1031	10C/2220
C ₂₇	40 μ F	1648	10C/3383
C ₃₀	.0006 μ F	1676	10C/3415
C ₃₁	.0006 μ F	1676	10C/3415
C ₃₂	.004 μ F	1505	10C/3105

RESISTANCES			
Annotation	Value Ohms	Type	Stores Ref. No.
R ₁ , R ₂	51,000 or 24,000 (1 offs or 27,000 (1 offs	868 or 6119	10C/677 or 10C/6119
R ₃	50,000	1043	10C/1043
R ₄	20,000	1044	10C/1044
R ₅ , R ₆	75,000	1045	10C/1045
R ₇ , R ₈	12,000 + 2,000	1046	10C/1046
R ₉	5,000	1047	10C/1047
R ₁₀	350	1048	10C/1048
R ₁₁	15,000	1049	10C/1049
R ₁₂	20,000	1050	10C/1050
R ₁₃	680	1053	10C/1053
R ₁₄	7,500	1051	10C/1051
R ₁₅	820	1052	10C/1052
R ₁₆ -R ₁₈	10 + 19.5 + 19.5	1056	10C/1056
R ₁₉ -R ₂₃	10 + 2.9 + 5.3 + 12.6 + 69.2	1055	10C/1055
R ₂₄	5,100 or 4,700	942 or 917	10C/877 or 10C/1872
R ₂₅	510	868	10C/677
R ₂₇ , R ₂₈	10 + 6	1054 or 6833	10C/1054 10C/6833
R ₂₉	150	1931	10C/1931
R ₃₀ and R ₃₁	1.5	8208	10C/8208
R ₄₀	100	1903	10C/1903
R ₄₁	1 M	95	10C/7908

The aerial selector switching unit, type J

67. The airborne equipment is connected to the appropriate aerial through a five-position exterior switch which is connected to the aerial terminals on the transmitter. A trailing aerial is normally used for the M.F. RANGES and a fixed aerial for the H.F. From the aerial terminal the circuit is completed through contacts of the relay REL₁ and the output circuits. The correct aerial is selected through the operation of the frequency range switch S₁ and provision is made by switch adjustment, for the use of either fixed or trailing aerals in the event of a breakdown of either.

68. The fixed aerial is used for D/F purposes but the energizing circuit of the H.T. power unit is then broken by the secondary contacts of an auxiliary switch which is ganged to the main switch and transmission is prevented. When heavy static conditions prevail the EARTH position of the switching unit is used. Both fixed and trailing aerals are directly earthed at the switch; the H.T. power unit circuit is broken, thus preventing use of the transmitter. The diagram of fig. 9 shows the theoretical circuit connexions of the aerial switching unit in the five positions, with the conditions obtaining at an auxiliary switch.

The aerial selector plug board

69. On a limited number of installations, an aerial selector plug board is fitted instead of the aerial switching unit, type J. The connexions of the plug board are shown in fig. 10. Changing over the sockets on the centre pair of plugs makes it possible to obtain the following transmitter combinations of aerial connexion to the equipment: M.F. transmission on trailing aerial; H.F. transmission on fixed aerial. This constitutes the normal position and is used when both aerals are serviceable. Either aerial may be used should one become defective, the change-over being effected by re-arrangement of the plugs.

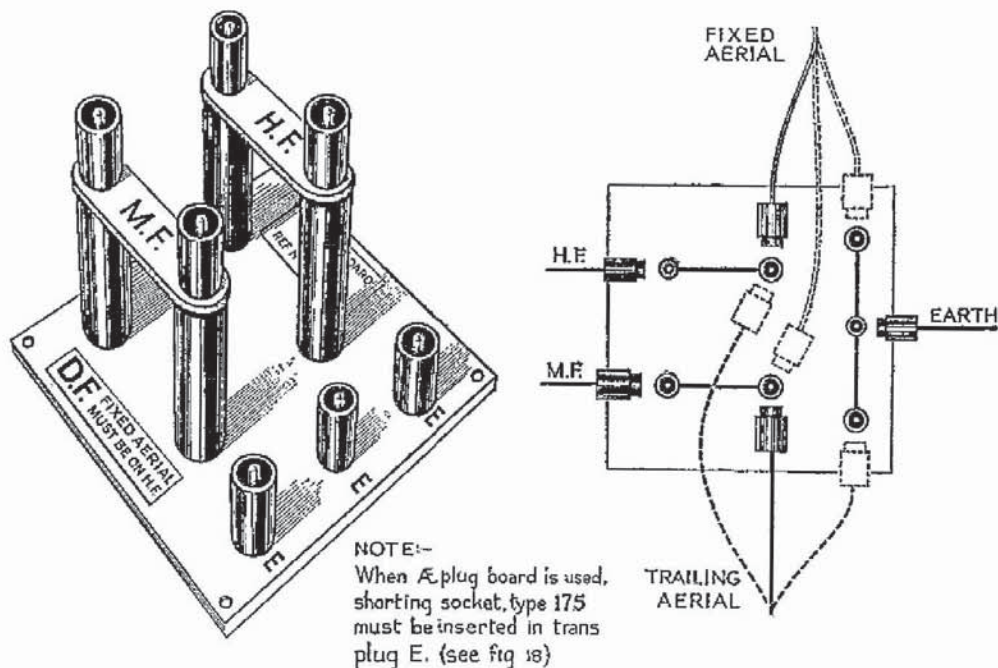


FIG. 10.—AERIAL PLUG BOARD CONNEXIONS

70. When the aerial plug board is used a socket, type 175 (Stores Ref. 10H/425) is required for plugging into the D/F interlock position, plug E, on the transmitter to make and break the input to the H.T. power unit. The internal connexions of this socket are shown in fig. 9. The pins 13 and 14 and pins 15 and 16 are short-circuited externally.

Socket and plugs

71. The connexions of the sockets A, F.Ae, T.Ae and Earth with the plugs B, C, D and E which are common to all transmitters when used as airborne equipment are set out, with the relevant connector sets, in para. 101. The MIC socket included in the R/T version is also given.

CONSTRUCTIONAL DETAILS

72. Illustrations of a typical transmitter are given in figs. 1, 11, 12, 13, 15 and 16. The general appearance is shown in fig. 1. A rear view with the case removed is shown in fig. 11. Side, top and bottom views of the instrument are given in figs. 12, 13, 15 and 16. A diagram of the click stop mechanism is shown in fig. 14 and a bench-wiring diagram of the C.W. and M.C.W. instrument in fig. 17. Certain structural alterations, notably the style of the sliding contact switch gauge with the frequency range switch in T.1154C have not been dealt with in this section.

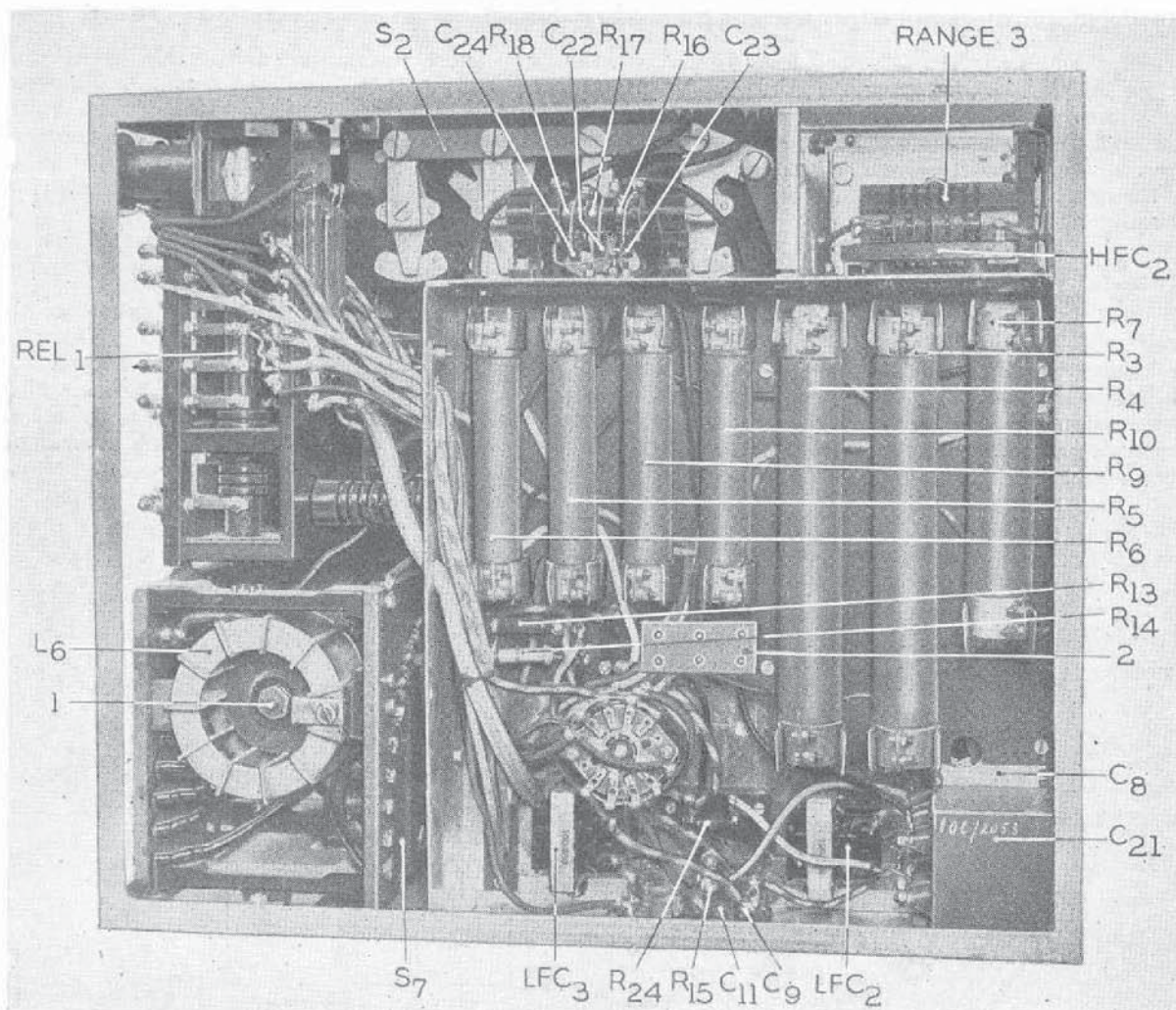


FIG. 11.—REAR VIEW OF THE TRANSMITTER WITH CASE REMOVED

73. The front panel controls of the instrument are shown in fig. 1. The master switch S₅ is located in the centre of the panel immediately below the LIFT TO RELEASE knob (1) which enables a small panel to be removed so that access to the valve compartment may be obtained. The switch S₅ has five positions on C.W. and M.C.W. versions with an additional position in R/T versions. The illustration on fig. 1 does not show the R/T position as it represents a T.1154A. The frequency range switch S₁ is located at the bottom left-hand corner of the panel and has three positions (four for the T.1154C) engraved with the frequency coverage.

74. There are three controls in the BLUE RANGES and these are colour coded accordingly. The M.O. tuning condenser for this RANGE, C₂ is provided with a "click-stop" mechanism giving eight different positions which may be pre-set to coincide with any eight "spot" frequencies within the limits of the RANGE. These eight click-stops are lettered from A to H and the frequencies can be recorded for reference on an ivory panel (2).

75. The switch S₃ is used to connect the aerial to any of the nineappings on the BLUE output coil L₄. The control of the output tuning condenser C₁₅ is positioned at the top right-hand corner of the panel and is also provided with eight click-stops engraved similarly to those of the M.O. tuning condenser.

76. The three controls of RANGE 2 (RANGE 3 of T.1154C) are coloured RED. The control of the M.O. tuning condenser C_4 is located immediately above that of C_2 . The click-stops are labelled J, K, L, M, N, P, Q, and R. A tap switch S_4 associated with this RANGE is located below S_3 and connects the aerial to any one of theappings on the coil L_5 . The condenser C_{10} is the output tuning condenser for this range and has click-stops engraved in accordance with the lettering of C_4 .

77. There are four controls in the RANGE 3 (RANGE 4 of T.1154C), coloured YELLOW. The M.O. tuning control of C_{17} is at the top left-hand corner of the panel and is similar to those of the M.O. condensers for the other ranges. The eight click-stops are engraved S, T, U, V, W, X, Y and Z. The switch S_7 is the aerial coarse tuning switch and is situated to the right of the master switch S_5 . The switch S_7 has seventeen positions numbered 1 to 17 and varies the amount of inductance in the aerial tuning coil L_6 .

78. The output fine tuning control of the aerial coil L_6 is immediately below the output tuning of RANGE 2. It consists of a sliding core inside the coil. As the change in frequency between theappings is small in comparison with that of other RANGES no click-stops are provided. The anode tap switch S_6 provides for seventeen positions numbered 18 to 34. The switch S_6 changes the position at which the output of the power amplifier is connected to L_6 .

79. The M.O. controls C_2 and C_4 are provided with vernier adjustment controls (3) and (4). These allow for a variation of plus or minus 0.1 per cent. on any of the pre-set frequencies. A release mechanism is provided for the click-stops of C_2 , C_4 , C_{15} , C_{18} and C_{17} . These release controls enable the dials to be rotated without engaging the click-stops so that any frequency within the limits of the particular range can be selected. In the illustrations, these controls are identified as (5), (6), (7), (8) and (9). A friction drive is brought into use when the click-stops are released thus preventing the controls from vibrating off their setting.

80. At the top of the panel, immediately above the valve compartment, is the milliammeter M_1 . This instrument reads from 0-300 milliamperes and indicates the current taken by the anodes of V_2 and V_3 . The aerial ammeter M_2 is located to the right of M_1 and reads from 0-3.5 amp. when in circuit for the YELLOW RANGE. An external aerial ammeter is provided for the H.F. RANGES.

81. The socket A and the plugs B, C and D are below the master switch S_5 . The socket A has eight contacts and caters for the receiver power supplies. B is the key and telephone plug, C the H.T. (1,200 volts) positive plug and D the main power supply plug. The openings in the transmitter case, through which connexions are made to plug E, to the fixed aerial, to the trailing aerial, and to earth, are also indicated. In the transmitter designed for R/T, microphone sockets are below the valve compartment; these are not shown in fig. 1. When used with electro-magnetic microphones the amplifier A.1134 is connected to the microphone socket. The H.T. fuse F_1 is immediately below the two meters. The fuse is of the glass tubular type and is rated at 750 milliamperes. It is protected and held in position by an insulated cap which screws on to the panel.

82. The transmitter is robustly constructed, being assembled on the separate unit principle to facilitate repair or replacement. The complete chassis is detachable from the containing box which is mounted on rubber suspension units (10) to prevent mechanical shocks and vibration. This minimizes the possibility of the frequency of the M.O. stage being rendered unstable. The cable connexions to the transmitter are equipped with non-reversible and non-interchangeable plugs and sockets. Wherever possible, supply cables are metal braided and have the braiding earthed to reduce electrical interference. The M.O. stage is carefully screened.

83. Two aspects of the keying relay REL_1 can be seen in figs. 11 and 12. The former illustration shows the construction of the coil L_6 with its associated core (1) for permeability tuning. The microphone link panel (2) is the contactor for the carbon-electro-magnetic microphone switches (not shown). The mechanism of the frequency change switch S_2 can be plainly seen in fig. 11. The plugs annotated as E and Earth and the terminals F.Ae and T.Ae appear in fig. 12. The semi-circular commutator device incorporated in the condensers C_{15} and C_{18} is attached to the spindles (1) and (2) seen in this illustration. One of the contacts of the device, that of C_{16} , appears as (1) in fig. 15. It should be noted that the annotations in brackets on this illustration refer to the contacts of the magnetic relay, type 85.

84. A semi-circular commutator having two brushes is fitted to the spindles of the condensers C_{15} and C_{18} . This commutator is so arranged that the condenser completes one-half revolution with the brush contacts open and the other half revolution with the brush contacts closed. When the brush contacts are closed, part of the inductance L_4 is short-circuited. The angular setting of the commutator permits the condenser to sweep from the maximum to minimum capacitance with the commutator brush contacts open. In the same manner the condenser sweeps from minimum to

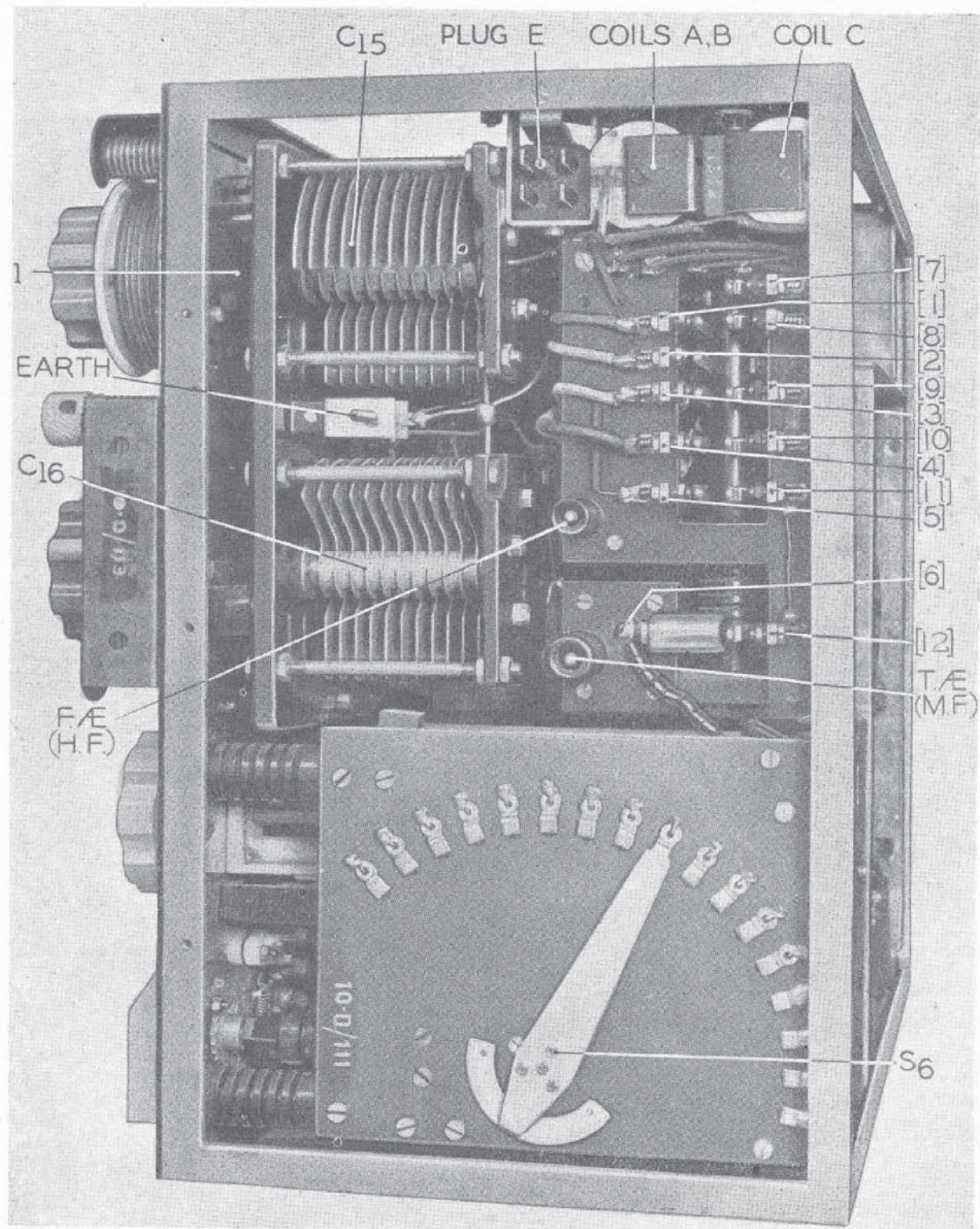


FIG. 12.—SIDE VIEW OF TRANSMITTER CHASSIS

maximum capacitance with the contacts closed. As the opening and closing of the commutator contacts alters the inductance value of L_1 , a greater range of tuning is achieved. This affords the tuning margin for coupling to a diversity of aerials.

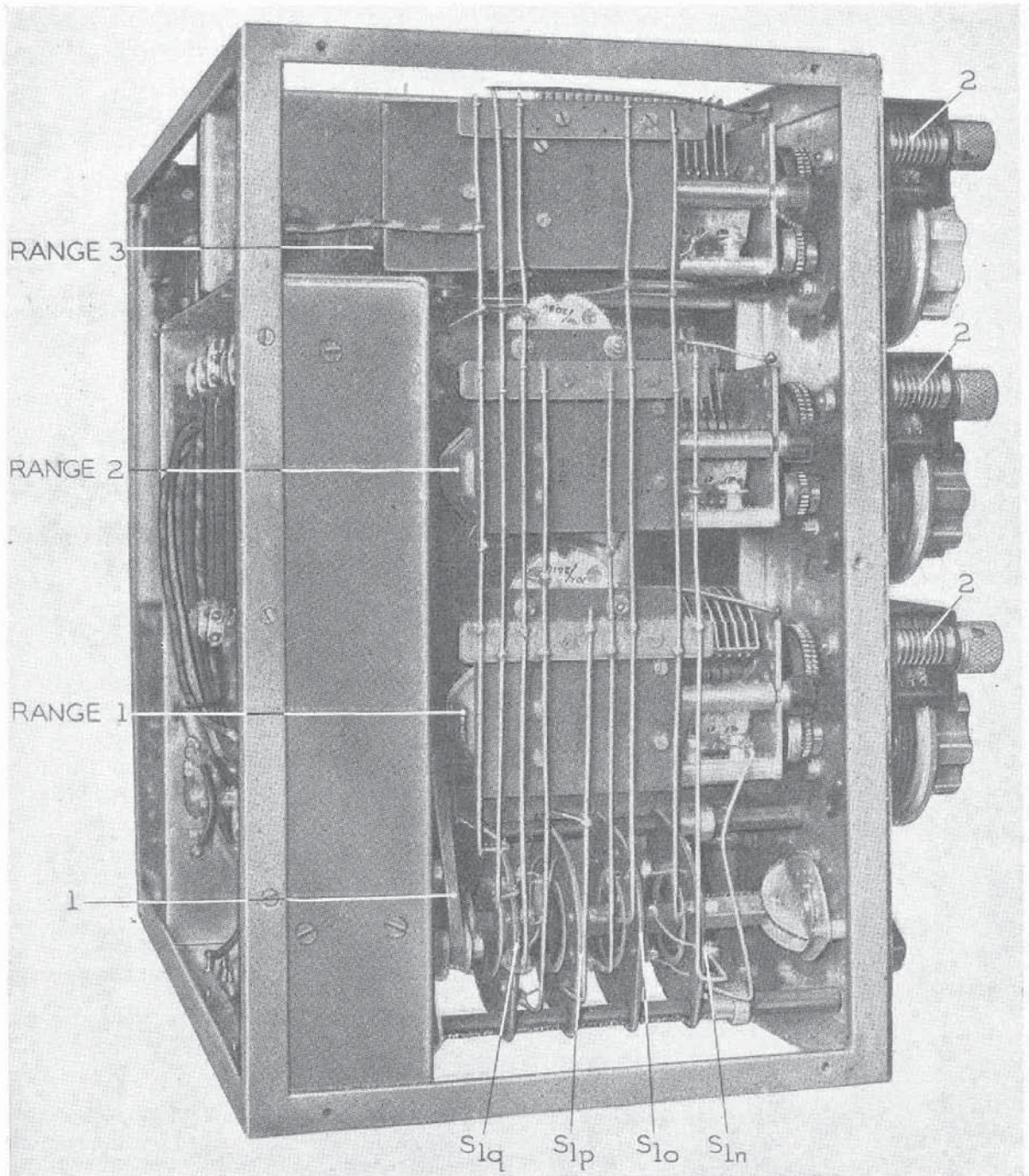


FIG. 13.—SIDE VIEW OF TRANSMITTER CHASSIS

85. The ganging link (1) between S_1 and S_2 can be seen in fig. 13 which presents a view of the M.O. end of the transmitter. The construction of S_1 and the connexions between this switch and the range coils and condensers can be traced. The click-stop mechanism (2) is partly visible in this illustration and the details are supplemented in the diagram, fig. 14.

The click-stop mechanism

86. The original click-stop mechanism, shown diagrammatically in fig. 14 is mounted on the M.O. controls for the three ranges and on the output controls for H.F. RANGES. It consists of eight split rings indicated on the diagram as a, b, c, d, e, f, g and h. Each ring has an external pip which engages in one of eight spring-loaded slotted bars, the pips being held in position in each slot by the action of the spring. Each ring and its indicating pip can be set to any position relative to the periphery of the main dial by slackening the locking screw. Each pip is marked with a different letter, the markings on fig. 19 corresponding to those on the BLUE RANGE. An improved version of this mechanism is being developed and will be described when available.

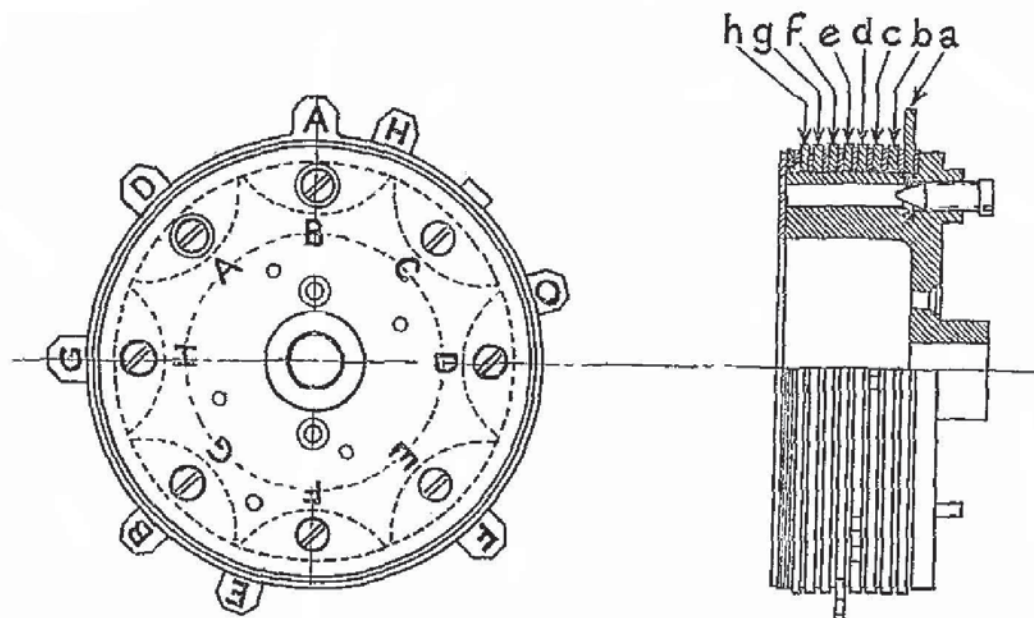


FIG. 14.—CLICK-STOP MECHANISM

87. The click-stop mechanism may be disengaged by means of a small knob control (*see* fig. 1) which lifts the set of spring-loaded bars by the action of a cam, thus preventing the pips engaging in the slots. Simultaneously, a friction drive is brought into action and this prevents the tuning dial from vibrating off its setting whilst in flight. An ivory frequency calibrated scale is provided. The minimum spacing between adjacent selected frequencies is approximately as follows: BLUE, 25 kc/s, RED, 10 kc/s and YELLOW, one kc/s.

88. A top view of the chassis is shown in fig. 15. The connexion panel (1) is associated with the frequency range switch S_1 . Another view of the condenser C_{15} can be seen in this illustration. The bevel gear (1) of the switch S_8 appears in fig. 16 which is an underside view of the instrument.

VALVES AND POWER SUPPLIES

89. Two types of valves are used in the transmitter. The M.O. and modulator valves are of the V.T.105 type (Stores Ref. 10E/216). These are non-metallized, indirectly-heated triodes, mounted on standard five-pin bases. The oscillator valve should have a ceramic base while the modulator may have the ordinary moulded base. The heater current is 0.7 amp. at 6 volts. In the power amplifier two pentodes, with standard, five-pin, ceramic bases are used and an anode connexion is brought out to the top of the envelope. These are of the type V.T.104 (Stores Ref. 10E/215) with filament current of 1.30 amp. at a nominal 6 volts.

90. The various electrode voltages and currents are shown in the accompanying TABLES which refer to transmitter types other than the T.1154C. These measurements were made with an instrument of 200,000 ohms resistance and are given for test purposes, if required.

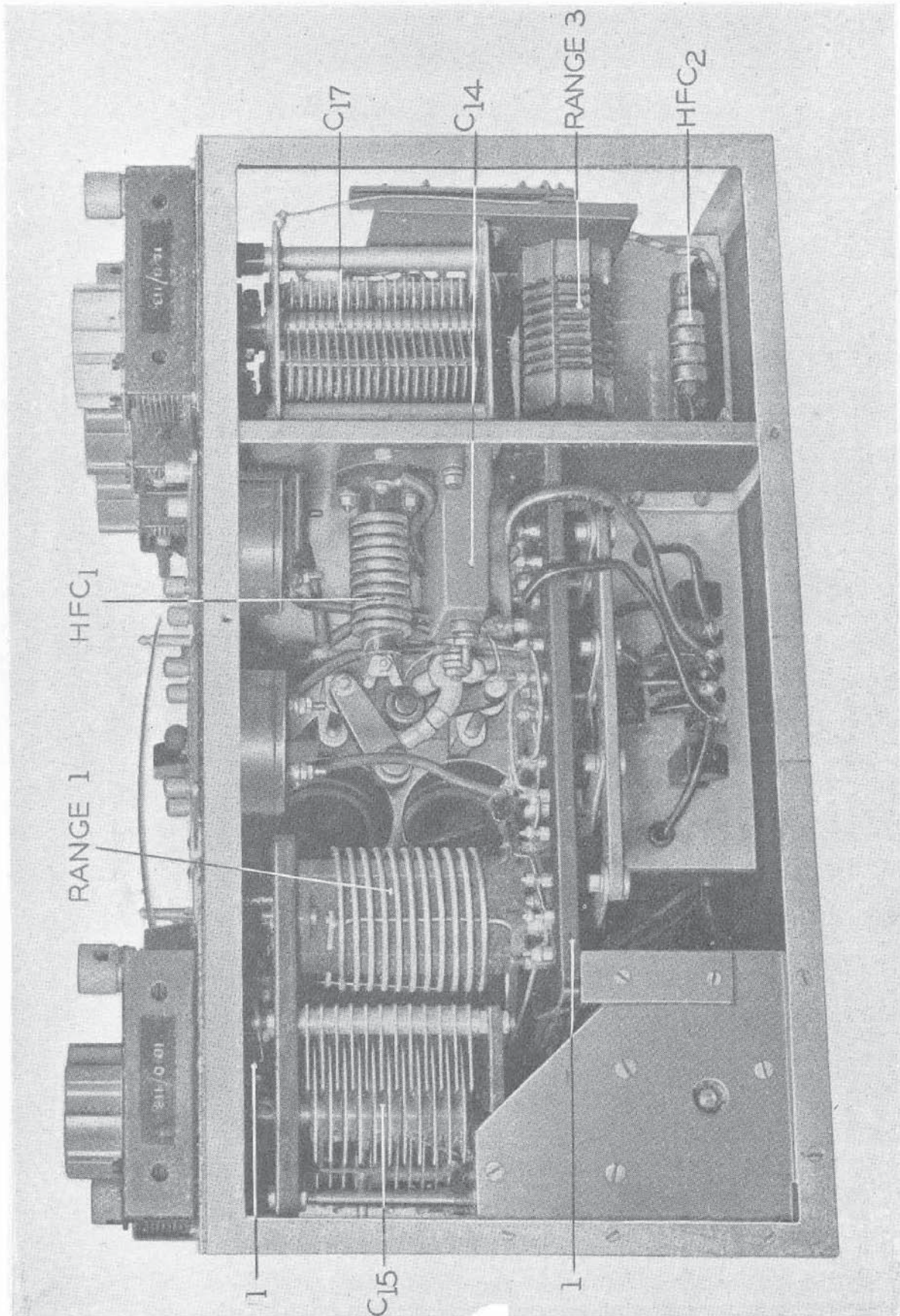


FIG. 15.—TOP SIDE VIEW OF TRANSMITTER CHASSIS

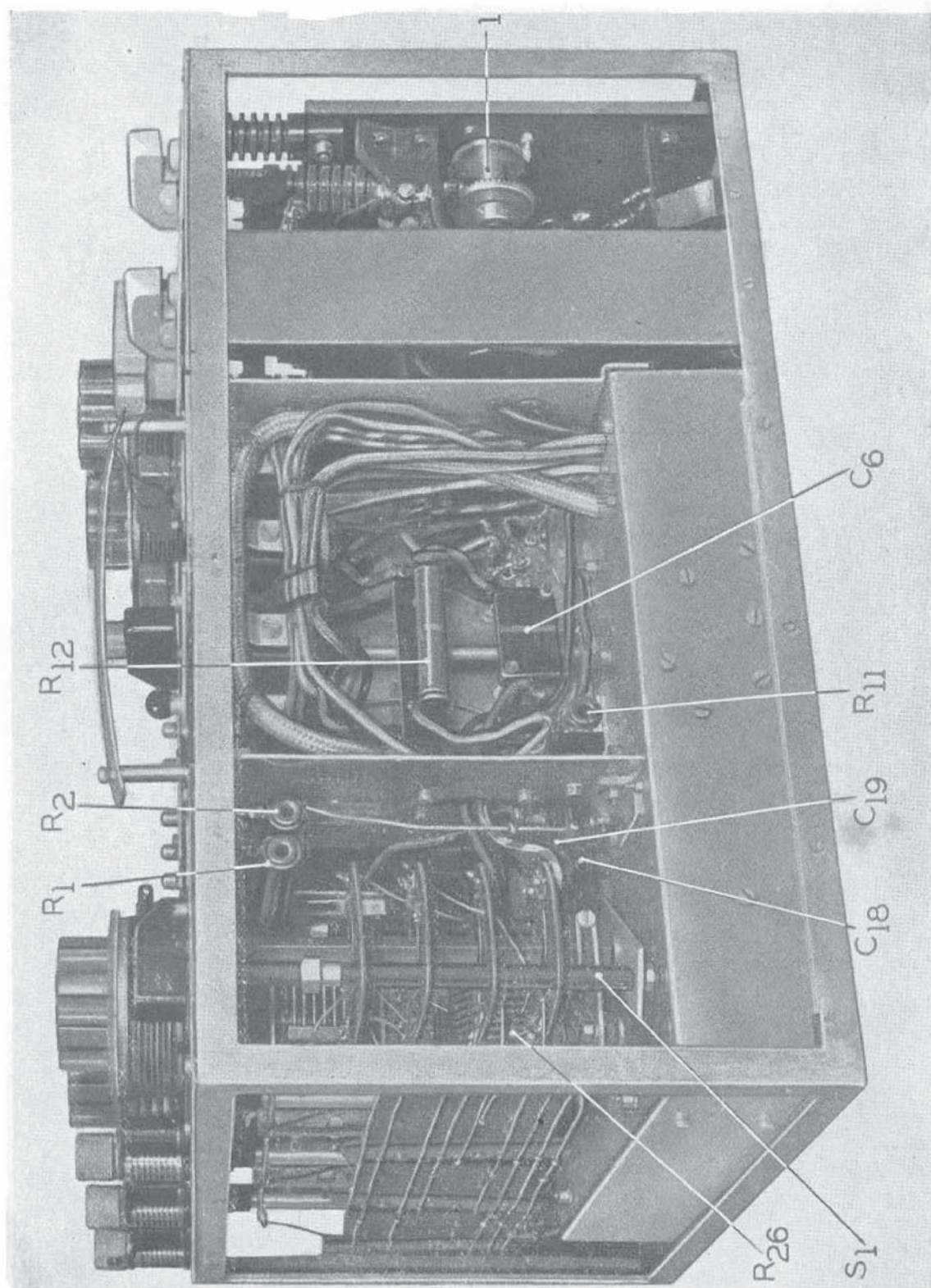


FIG. 16.—UNDERSIDE VIEW OF TRANSMITTER CHASSIS

TABLE C
MODULATOR VALVE V.T.105

Frequency	Range	H.T. supply	Anode volts				Anode current mA			
			Tune	C.W.	M.C.W.	R/T	Tune	C.W.	M.C.W.	R/T
200 kc/s	YELLOW	1,200	153	160	160	153	11.5	12	11.5	11.5
500 kc/s	YELLOW	1,200	153	160	160	153	11.5	12	11.5	11.5
3 Mc/s	RED	1,200	153	160	160	153	11.5	12	11.5	11.5
5 Mc/s	RED	1,200	153	160	160	153	11.5	12	11.5	11.5
6 Mc/s	BLUE	1,200	160	160	160	153	11.2	12	11.5	11.2
10 Mc/s	BLUE	1,200	160	160	160	153	11.2	12	11.5	11.2

OSCILLATOR VALVE V.T.105

200 kc/s	YELLOW	1,200	160	170	163	160	19.5	21	19.5	19.5
500 kc/s	YELLOW	1,200	212	233	224	212	17.7	18.6	17.8	17.7
3 Mc/s	RED	1,200	210	215	210	210	18.5	19	18.5	18.5
5 Mc/s	RED	1,200	225	235	225	225	18	18.5	18	18
6 Mc/s	BLUE	1,200	260	270	260	260	17	18	17	17
10 Mc/s	BLUE	1,200	240	250	240	240	18	18	17.5	17.5

NOTE.—On RANGE YELLOW the anode current given above includes the drain through the resistance R_1 and R_2 .

91. The following TABLE D refers to measurements on the power amplifiers V_2 and V_3 . The figures for the suppressor grid current (I_{g3}) are very variable with different valves but this is permissible within wide limits without affecting the performance of the transmitter.

TABLE D—Sheet 1
POWER AMPLIFIER VALVES, V.T.104
TUNE and R.T.

Frequency	200 kc/s.	500 kc/s	3 Mc/s	5 Mc/s	6 Mc/s	10Mc/s
RANGE	YELLOW	YELLOW	RED	RED	BLUE	BLUE
H.T. supply v.	1,200	1,200	1,200	1,200	1,200	1,200
Ea v. ...	1,160	1,160	1,155	1,155	1,155	1,155
Indicated Ia mA	98	58	55	60	58	58
True Ia mA ...	40	58	55	60	58	58
Ig 1 mA ...	2.1	4	4.2	4.6	4	3.4
Eg 2 v. ...	200	243	240	240	255	220
Ig 2 mA ...	34	28	29	28	27	32
Eg 3 v. ...	— 40	— 40	— 45	— 45	— 45	— 45
Ig 3 mA ...	0	0	0	0	0	0

TABLE D—Sheet 2
C.W.

Frequency	200 kc/s	500 kc/s	3 Mc/s	5 Mc/s	6 Mc/s	10 Mc/s
RANGE	YELLOW	YELLOW	RED	RED	BLUE	BLUE
Ea v. ...	1,200	1,200	1,200	1,200	1,200	1,200
Indicated Ia mA	114	95	115	93	96	92
True Ia mA ...	45	95	115	93	96	92
Ig 1 v. ...	2.2	4	4.2	4.6	4	3.5
Eg 2 v. ...	215	278	300	273	290	250
Ig 2 mA ...	34	25	24	26	24	29
Eg 3 v. ...	+ 20	+ 30	+ 35	+ 30	+ 32	+ 20
Ig 3 mA ...	7	6	3	5.5	4.5	7.5

M.C.W.

Ea v. ...	1,155	1,150	1,150	1,150	1,153	1,155
Indicated Ia mA	85	53	55	55	50	56
True Ia mA ...	34	53	55	55	50	56
Ig 1 mA ...	2.1	4	4.2	4.6	4	3.4
Eg 2 v. ...	200	240	243	240	250	220
Ig 2 mA ...	34	28	28	28	27	31
Eg 3 v. ...	— 46	— 50	— 50	— 50	— 47	— 45
Ig 3 mA ...	1.6	1.3	1.0	1.0	1	0

92. The following TABLE E applies particularly to the T.1154C:—

TABLE E
OSCILLATOR VALVE V.T.105

200 kc/s	YELLOW	1,200	160	170	163	160	19.5	21	19.5	19.5
500 kc/s	YELLOW	1,200	212	233	224	212	17.7	18.6	17.8	17.7
2.5 Mc/s	RED	1,200	314	330	315	315	16.5	16.2	15.6	15.6
4.5 Mc/s	RED	1,200	294	305	295	294	16.1	17.8	16.1	16.1
4.5 Mc/s	BLUE 2	1,200	300	315	302	302	16.9	17.5	17.0	17.0
8.7 Mc/s	BLUE 2	1,200	260	265	256	256	17.9	18.6	18.0	18.0
8.7 Mc/s	BLUE 1	1,200	235	242	236	236	18.5	19.3	18.5	18.5
16.7 Mc/s	BLUE 1	1,200	220	230	221	221	18.9	19.5	18.9	18.9

Note.—On range YELLOW the anode current given above includes the drain through the resistances R_1 and R_2 .

93. The following TABLE F refers to measurements on the power amplifiers V_2 and V_3 of T.1154C. The figures for the suppressor grid current (I_{g3}) are very variable with different valves but this is permissible within wide limits, without affecting the performance of the transmitter.

TABLE F
POWER AMPLIFIER VALVES V.T.104
TUNE and R.T.

Frequency	200 kc/s	500 kc/s	2.5 Mc/s	4.5 Mc/s	4.5 Mc/s	8.7 Mc/s	8.7 Mc/s	17 Mc/s
RANGE	YELLOW	YELLOW	RED	RED	BLUE 2	BLUE 2	BLUE 1	BLUE 1
H.T. supply v. ...	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Ea v. ...	1,160	1,160	1,160	1,160	1,160	1,160	1,160	1,160
Indicated Ia mA	98	58	58	58	58	58	58	58
True Ia mA ...	40	58	62	60	65	60	63	70
Ig 1 mA ...	2.1	4.0	5.0	4.1	4.4	3.8	1.8	2.2
Eg 2 v. ...	200	243	285	245	284	272	260	281
Ig 2 mA ...	34	28	23.5	29	24	25.5	26.5	24.2
Eg 3 v. ...	- 40	- 40	- 50	- 50	- 50	- 50	- 50	- 53
Ig 3 ...	0	0	0	0	0	0	0	0

C.W.

Ea v. ...	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Indicated Ia mA	114	95	95	95	95	95	95	95
True Ia mA ...	45	95	115	125	112	117	120	119
Ig 1 mA ...	2.2	4.0	5.0	4.0	4.3	3.8	1.8	2.3
Eg 2 v. ...	215	278	360	332	355	340	330	360
Ig 2 mA ...	34	25	16.2	20.1	17.2	19.5	20.5	21.2
Eg 3 v. ...	+ 20	+ 30	+ 52	+ 49	+ 51	+ 50	+ 50	+ 60
Ig 3 mA ...	7	6.0	6.0	6.0	6.0	6.0	6.0	6.0

M.C.W.

Ea v. ...	1,155	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Indicated Ia mA	85	53	53	53	53	53	53	53
True Ia mA ...	34	53	62	65	60	60	63	70
Ig 1 ...	2.1	4.0	5.1	4.0	4.4	3.8	1.8	2.2
Eg 2 ...	200	240	289	260	280	270	260	272
Ig 2 ...	34	28	23.5	27	24.5	25.5	26.7	25
Eg 3 ...	- 46	- 50	- 50	- 51	- 50	- 50	- 50	- 54
Ig 3 ...	1.6	1.3	1.3	1.3	1.3	1.3	1.3	1.3

94. Power supplies for the airborne transmitters are derived from units embodying rotary transformers. These units may be of a nominal 24-volt or 12-volt input derived from the aircraft general electric system accumulators. Two power units are used for each installation, one supplying all L.T. requirements for both transmitter and receiver (or receivers, in installations where a separate

navigator-operated receiver is included) with H.T. for the receiver. The second power unit has one output supply of 1,200 volts, 200 mA for the transmitter H.T. The power units are described, in detail, at the end of this chapter (paras. 181 to 211).

95. The power supplies for transmitters, types T.1154D and T.1154E, used in a mobile application, are derived through a unit, which is essentially a rectifier, supplied from the 230-volt, 50 c/s single-phase A.C. mains. This unit is the rectifier, type 26 (Stores Ref. 10D/745) and is a constituent part of the tender, signals, type 309, used in the mobile ground station T.1154D and E—R.1188. This rectifier unit will be described in the appropriate section of AIR PUBLICATION 1095.

96. When the T.1154—R.1155 group equipment is used at training establishments, and for demonstration purposes, on the ground, the power supplies are obtained from the 200-250 volt, 50 c/s, single-phase A.C. mains *via* either the power unit, type 114 (Stores Ref. 10K/350) or the power unit, type 115 (Stores Ref. 10K/351). These power units are the subject of Chap. 18, Sect. 6, of this AIR PUBLICATION.

97. The power unit, type 114, comprises two separate sections, one of which, known as the main, supplies the transmitter and receiver L.T. with receiver H.T. and the second, or H.T. unit, supplies the transmitter H.T. The power unit, type 115, is a single unit rectifier which, in conjunction with a "floating" 24-volt accumulator (two 12-volt, type B, lead-acid accumulators in series) supplies the prime voltage for the two power units of the 24-volt type, as normally used in airborne installations.

INSTALLATION

98. A typical installation diagram giving the alternative connexions for single receiver and double receiver installation, is shown in fig. 18. A typical schedule of connectors is included on this diagram but having regard to the variations of connector sets imposed by the number of aircraft types in which this equipment is used, space on the diagram precluded a complete schedule. The connector schedule, taken to a stage of completion at the time of writing, is given in an APPENDIX to this chapter.

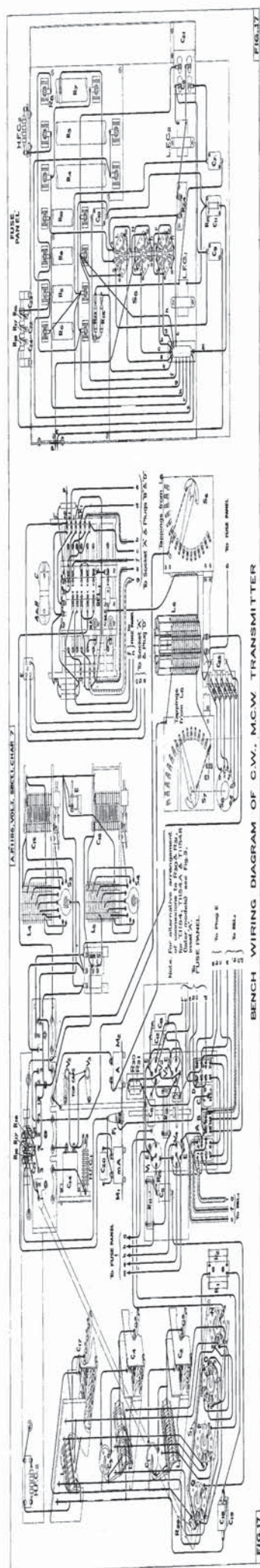
99. In setting out an installation for this equipment a degree of duplication of the information, given in Chap. 6, Sect. 3, of this AIR PUBLICATION for the receiver R.1155, is unavoidable. As the airborne equipment is interlocked to a great extent it has been considered advisable that the information given should be, as far as possible, grouped to avoid cross-reference. The transmitter valves are arranged in two compartments to which access may be obtained by means of a door (1, fig. 1). The left-hand compartment contains the two V.T. 105 valves, that in the foreground being V_4 and the one at the rear V_1 . Ceramic based valves, type V.T.105 only, are to be used in the M.O. V_1 position. Either black or white based valves may be used in the modulator, V_4 , position. The right-hand compartment contains the two V.T.104 power amplifiers V_2 and V_3 and the anode connectors of these should make firm contact.

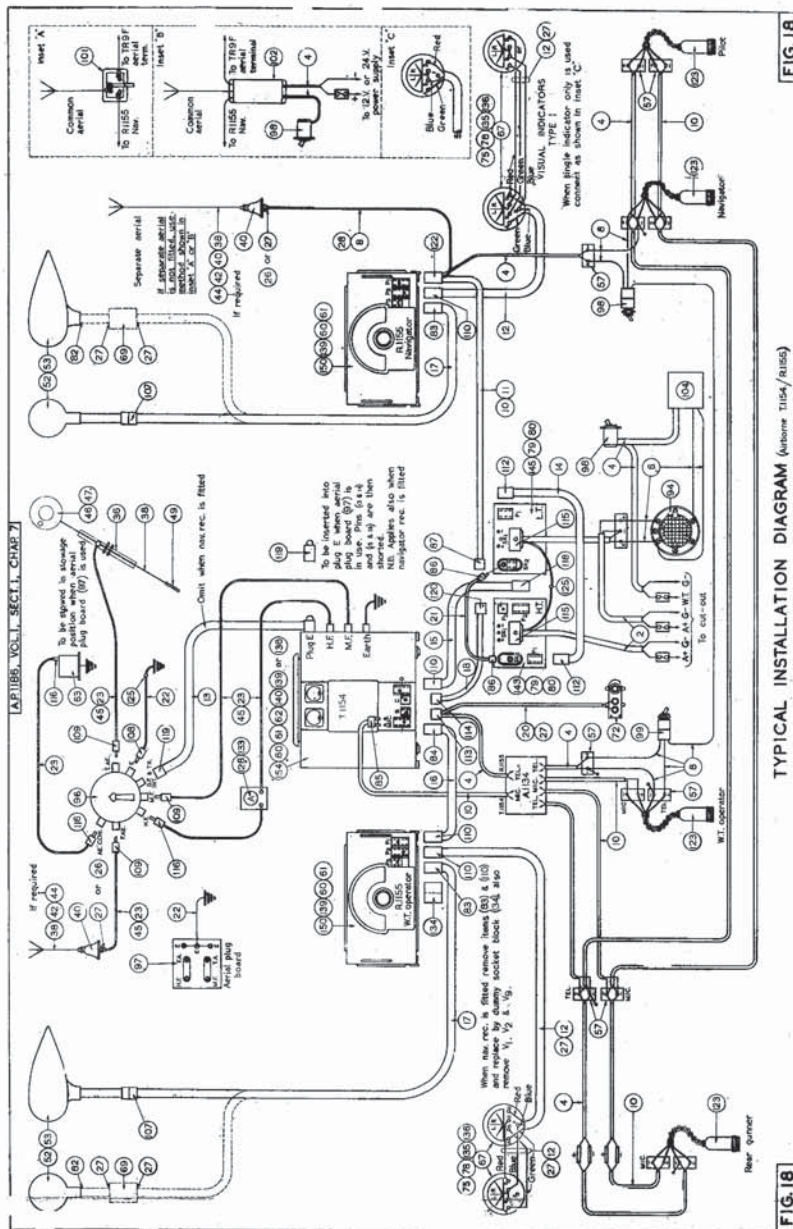
100. From a preliminary survey of the installation diagram, it will be seen that the transmitter is the main focal point for all the wiring. The connectors from the power units plug into the transmitter and so, also, do the two aerials, fixed and trailing, and the receiver inter-connexion. The D/F circuits alone (loop and visual indicators) plug into the receiver.

101. The accompanying TABLE G shows the various points of the transmitter socket and plugs, the connectors to four of which are held in position by a retaining bar (2, fig. 1) on the front panel. This bar engages with two posts (11, fig. 1).

TABLE G
TRANSMITTER SOCKETS AND PLUGS CONNEXIONS

Pin	Sk. A	Plug B	Plug C	Plug D	Plug E	Mic. Sk.	Earth Sk
+						+	
—						—	
1	H.F.Ae		1,200 v. + H.T.	220 v. —			
2	M.F.Ae			220 v. +			
3	L.T. +			Starter fls. and Recr. H.T. P/U			
4	L.T. —			Acc. 12 v. +			





TYPICAL INSTALLATION DIAGRAM (Aeron 1154/1155)

FIG. 18

FIG. 18

INSTALLATION SCHEDULE

Item No.	Stores Ref. No.	Description	Item No.	Stores Ref. No.	Description
GENERAL WIRING			79	10A/12421	Mounting type 51
2A	5E/1364	Cable L.T. Ducel 19 Cellse. braided; or	80	10A/12422	Mounting type 52
2B	5E/1365	Cable L.T. Ducel 37 metal braided	82	10H/9872	Plug type 101
4	5E/1362	Cable L.T. Ducel 4 Cellse. braided	83	10H/433	Plug type 209
6A	5E/1360	Cable electric L.T. Unisel 19 Cellse. braided; or	84	10H/434	Plug type 210
6B	5E/1361	Cable electric L.T. Unisel 37 Cellse. braided	85	10H/451	Plug type 217
8	5E/1358	Cable electric L.T. Unisel 4 Cellse. braided	86	10H/8516	Plug type 68
10	5E/1328	Cable electric L.T. Dumet 4 metal braided	87	10H/1518	Plug type 358
11	5E/1348	Cable electric L.T. Dumet 7 metal braided	92	10A/12426	Plate anchorage type 1
12	5E/1351	Cable L.T. Trimet 4 metal braided	94A	10C/2221	Resistance unit type 47
13	5E/1353	Cable L.T. Quadramet 4 metal braided	94B	10C/2295	Resistance unit type 52
14	5E/2069	Cable electric Sextocorem	96	10F/126	Switch unit type J; or
15	5E/2067	Cable electric Octocorem No. 1	97	10H/681	Aerial plug board
16	5E/2068	Cable electric Octocorem No. 2	98	5C/543	Switch box type B 1 unit
17	5E/2033	Cable electric H.F. Dulocapmet No. 1	99A	10F/11714	Switch type 170 S.P.C.O.; or
18	5E/758	Cable H.T. Uniplugmet No. 1	99B	5D/531	Switch 2 amp. miniature S.P.C.O.
20	5E/916	Cable L.T. Unisheath 4 red braided	101	10H/1276	Switch type 9 S.P. 2 way; or
21	5E/130	Cable L.T. Unisheath 7 unbraided	102A	10F/752	Relay type 265 (12-v); or
22	5E/	Cable L.T. Uniflex 19 red braided	102B	10F/725	Relay type 258 (24-v)
23	5E/82	Cable H.T. Unispark 7 unbraided	104A	10F/493	Relay type 219 LONDEX; or
26	5A/912	Cable end eye type O.B.A.	104B	10F/494	Relay type 220 LONDEX
27	5A/911	Cable end eye type 4 B.A.	106	10H/8531	Socket type 40
28	5A/910	Cable end eye type 6 B.A.	107	10H/11051	Socket type 63
31	5A/1810	Cable end hook type crimping Uniflex cable	108	10H/319	Socket type 135
34	5A/1073	Sleeve identification Uniflex cable	109	10H/320	Socket type 136
W.T. FIXED EQUIPMENT			110	10H/322	Socket type 137
36	Special	Ae. frld. com. with lghtn. arrt. type C	112	10H/427	Socket type 168
38	10B/8235	Ae. wire stainless steel	113	10H/428	Socket type 169
40A	10B/8093	Ae. insulator type 16 (lead in); or	114	10H/429	Socket type 170
40B	10B/11457	Ae. insulator type 49 (lead in)	115	10H/431	Socket type 171
42A	10B/8097	Ae. insulator type 17 (strain); or	116	10H/422	Socket type 172
42B	10B/8994	Ae. insulator type 18 (strain)	117	10H/423	Socket type 173
44	10B/9121	Ae. insulator type 18 (shroud)	118	10H/424	Socket type 174
45	10B/468	Ae. insulator type 177	119	10H/425	Socket type 175
46	10B/9005	Ae. winch type 5 frame	120	10H/435	Socket type 176
47	10B/9123	Ae. winch type 5 reel type B	122	10H/1498	Socket type 299
49A	10B/7298	Ae. weight bead type No. 1; or	123	10H/2206	Socket type 359
49B	10B/7706	Ae. weight bead type No. 2	125	5A/1058	Terminal 2 B.A. type A spring type
52	10B/8478	Ae. loop type 1; or	W.T. REMOVABLE EQUIPMENT		
53		Ae. loop type 3. Group to suit a/c	128A	10A/12227	Ammeter H.W. 0-4 amps. type A; or
57	5C/430	Block terminal type B 2 way No. 1	128B	10A/12667	Ammeter thermo 0-4 amps. type C
58	5C/432	Block terminal type B 3 way No. 1	131	10E/542	Box valve stowage
60	10A/12427	Block mounting type 1	133	10A/12674	Cover protective
61	10A/12428	Block mounting type 2	134	10H/1938	Dummy sockets block
63	10C/564	Condenser type 764	135	5C/462	Lamp instrument
67	10Q/2	Indicator visual type 1	136A	5L/1150	Lamp filament 12-v; or
69	10A/12148	Impedance matching unit type 12; or	136B	5L/1898	Lamp filament 24-v
69A	10A/12247	Impedance matching unit type 15	138	10A/12423	Mounting type 53
72	10A/7741	Key morse type F	139	10A/12424	Mounting type 54
73	Special	Label	140	10A/12425	Mounting type 55
75A	Special	Lamp holder; or	143A	10K/13063	Power unit H.T. type 32A; or
75B	10A/13078	Lamp holder type 61	143B	10K/13064	Power unit H.T. type 33A
78	10A/12954	Mounting anti-vibration type 119	145A	10K/13065	Power unit L.T. type 34A; or
			145B	10K/13066	Power unit L.T. type 34B
			150	10D/98	Receiver R.1155 (or R.1155A or R.1155B)
			154A	10D/97	Transmitter type T.1154; or
			154B	10D/99	Transmitter type T.1154A
			154C	10D/196	Transmitter type T.1154B; or
			154D	10D/198	Transmitter type T.1154C

TYPICAL CONNECTOR SET INSTALLATION

(Note.—This installation is typical and refers only to the SUNDERLAND type aircraft)

KEY TO BASIC TYPE NOS. AND FUNCTION

541	POWER UNIT H.T. to POWER UNIT L.T.	545	SWITCH UNIT TYPE J. to TRANSMITTER "D/F"
542	TRANSMITTER to RECEIVER	546	LOOP AERIAL, TYPE 3 to RECEIVER
543	POWER UNIT H.T. to TRANSMITTER	547	RECEIVER (NAV.) to POWER UNIT L.T. Only required when 2 Receivers fitted.
544	POWER UNIT H.T. to TRANSMITTER	548	Used in place of SWITCH UNIT, TYPE J (and also when 2 Receivers are installed.

Aircraft Type Identification Letter and Connector Set	Comprising Connector Set		Fitted with									Refer- ences in Figure
			Stores Ref. No.	Type	Stores Ref. No.	Cable Type	Length	Socket			Plug	
	Stores Ref. No.	Type						Qty.	Stores Ref. No.	Type	Qty.	
Sunderland Mk. II and Mk. III "A". Fitted with single receiver Connector Set Type T.1154/R. 1155 (Stores Ref. 10H/1556)	10H/1634	541/1	5E/2069	Sextocore- met	1' 3"	10H/427	168	2				14, 112
	10H/1635	542/1	5E/2068	Octocore- met No. 2	3' 2"	10H/322	137	1	10H/434	210	1	16, 110, 84
	10H/1636	543/1	5E/2067	Octocore- met No. 1	3' 0"	10H/322	137	1				15, 110
	10H/1637	544/1	5E/758	Uniplugmet No. 1	3' 6"	10H/424	174	1				118
						10H/429	170	1				18, 114
	10H/1638	545/1	5E/1353	Quadramet 4	1' 10"	10H/435	176	1				120
						10H/425	175	2				13, 119
	10H/1639	546/1	5E/2033	Dulocap- met No. 1	13' 8"	10H/11051	63	1	10H/433	209	1	17, 107, 83
	10H/1718	548/1	5E/1362	Ducel 4	6' 0"	10H/425	175	1				119
Fitted with extra Receiver R.1155 for D/F Connector Set Type T.1154/2 R.1155/A (Stores Ref. 10H/1735)	Items 10H/1634, 10H/1635, 10H/1636 and 10H/1718 as above. Item 10H/1637 is 4' 0" not 3' 6"											
	10H/2317	545/3	5E/2033	Dulocap- met No. 1	6' 6"	10H/11051	63	1	10H/433	209	1	17, 107, 83
	10H/1640	547/1	5E/1348	Dumet 7	25' 0"	10H/1498	299	1	10H/1518	358	1	11, 122, 87
			1328	Dumet 4	25' 0"							10
			1362	Ducel 4	9' 6"							4
Conversion of Single Recr. Instn. to Two Recr. Instn. Connector Set Type T.1154/R. 1155/Convsn./A (Stores Ref. 10H/1986)	Item 10H/2317 (below) replaces Item 10H/1339 when converting to two receiver installation											
	10H/2317	545/3	5E/2033	Dulocapmet	6' 6"	10H/11051	63	1	10H/433	209	1	17, 107, 83
	10H/1640	545/3	5E/1328	Dumet 4	25' 0"	10H/1498	299	1	10H/1518	358	1	10, 122, 87
			5E/1328	Dumet 7	25' 0"							11
			5E/1362	Ducel 4	9' 6"							4

The following items refer to 14 connectors without reference nos.:—

Stores Ref. No.	Cable	Approx. length	Ref. in fig.	Sockets			Ref. in fig.	Plugs			Ref. in fig.
				Stores Ref. No.	Type	Qty.		Stores Ref. No.	Type	Qty.	
5E/82	Unispark 7	21' 0"	23	10H/8531	40	1	106	10H/451	217	1	85
5E/86	Uniflex 19	6' 0"	22	10H/319	135	2	108				
5E/916	Unisheath 4	6' 0"	20	10H/320	136	4	109				
5E/1328	Dumet 4	4' 0"	10	10H/322	137	1	110				
5E/1349	Ducel 19	5' 0"	2	10H/428	169	1	113				
5E/1351	Trimet 4	14' 0"	12	10H/431	171	2	115				
5E/1362	Ducel 4	4' 0"	4	10H/422	172	4	116				
				10H/423	173	2	117				
The following items refer to 15 connectors without reference nos.:—											
5E/82	Unispark 7	19' 0"	23	10H/8531	40	1	106	10H/8531	68	2	86
5E/86	Uniflex 19	6' 0"	22	10H/319	135	2	108	10H/451	217	1	85
5E/916	Unisheath 4	7' 0"	20	10H/320	136	4	109				
5E/1328	Dumet 4	9' 0"	10	10H/322	137	1	110				
5E/1349	Ducel 19	4' 0"	2	10H/428	169	1	113				
5E/1362	Ducel 4	10' 0"	4	10H/431	171	2	115				
5E/1351	Trimet 4	28' 0"	4	10H/422	172	4	116				
5E/130	Unisheath 7	3' 0"	21	10H/423	173	2	117				
The following items refer to 2 connectors without reference nos.:—											
5E/1351	Trimet 4	18' 0"	4	10H/322	137	1		Replaces Recr. to Indicator connector Connector between power units			
5E/130	Unisheath 7	3' 0"	21	10H/8531	68	2					

TABLE G

Pin	Sk. A	Plug B	PLUG C	PLUG D	PLUG E	Mic. Sk.	Earth Sk.
5	Recr. H.T. 220 v. +			L.T. —			
6	Tels.			L.T. +			
7	220 v. +			1,200 v. —			
8	220 v. —			Starter, 1,200 v. P/U			
13		Key			L.T. +		
14		REL, key contact			L.T. + to relay in 1,200 v. P/U		
15		Earth			220 v. + Recvr. H.T.		
16		Tels.			220 v. +		

RELEVANT CONNECTORS	To Recvr.	To tels. and key	To power supply	To power supply	To aerial switch and interlock	To Mic.	To earth
	Octocore- met 2	Ducel 4 Unisheath 4	Uniplug- met 1	Octocore- met 1	Quadramet 4	Dumet 4	Uniflex 19
	Plug, type 210 Socket, type 137	Sk., type 169 Cable end eye to Sk., type 359, or Ampl. A.1134 (or other type)	Sk., type 170 Socket, type 176	Sk., type 137 Sk., type 174	If aerial plug board fitted or if navigator operated R.1155 used. Sk., type 175	Sk., type 359 or Ampl. A.1134 (or other type)	Sk., type 135 Cable end hook

102. In laying out the equipment in the aircraft, the receiver is placed in the most convenient position for operation. The transmitter is mounted above, or to one side of the receiver. The receiver is mounted so that the tuning scales are easily visible and accessible to the operator, and the YELLOW, RED and BLUE click-stop dials on the transmitter can be seen without effort.

103. The receiver is normally positioned horizontally. In exceptional circumstances it may be mounting vertically. A distance of $1\frac{1}{2}$ in. to 2 in. is allowed between the transmitter and receiver, if mounted one above the other, to permit freedom of movement for the suspension fitting. Clearance around the transmitter and receiver permits removal and replacement of plugs and sockets and of the chassis themselves and allows access to the transmitter case retaining screws.

104. The transmitter may be back, "table" or base mounted. The method depends upon the particular aircraft layout. The instrument is associated with the mountings type 53 (Stores Ref. 10A/12423) and type 54 (Stores Ref. 10A/12424). Check devices consisting of two steel chains (Stores Ref. 10A/12926) are fitted to each rubber suspension on the mountings to prevent damage to the equipment when subjected to violent shock. Instructions have been issued in leaflet form to provide for the fitment of the chains. Two chains are fitted between the central bolt securing the suspension to the mounting, type 53 or 54 and the bolts at the side securing the suspension to the transmitter or receiver. Four chains are fitted per mounting. The apparatus is put in a position where the natural illumination, through windows or ports, is good. For night work artificial illumination is provided and this consists of an adjustable light which may be thrown on any part

of the apparatus at will. The illumination is variable in intensity by means of a dimmer switch. It is usual to provide an independent light (from the left-hand side) for writing purposes and this is also adjustable. No internal illumination is provided with this equipment.

105. The W/T key (72, fig. 18) is positioned on the right-hand side of the operator's tables and just far enough back from the edge to enable the wrist to rest on the table top. Relevant information as to the ideal positioning of the operator's table, seat and other facilities can be found elsewhere in AIR PUBLICATIONS.

106. The power units are mounted on the floor in an accessible position and if placed below the operator's table, so situated that they are not liable to be kicked. They may be mounted one over the other. They are mounted on their side. The ends from which connexions are taken are accessible from inside the cabin without removing the machines from their mounting or dismantling any other equipment. Care should be exercised to prevent interchange of the type 171 input supply sockets (115, fig. 18) between the two power units because the L.T. supply of 12 or 24 volts is connected straight on to the H.T. power unit whereas with the L.T. power unit it is taken through a dropping resistance (94, in fig. 18) first.

107. The power units are at least 48 in. away from the aircraft compass. At that distance they, conjointly, produce a deflection of less than 1 degree. The transmitter is over 30 in. from the compass and the receiver 24 in. The ammeter is 24 in. and the visual indicator 18 in. distant to guarantee negligible interference.

108. Due to the heavy current taken by the apparatus, separate cables are used for the H.T. and the L.T. power units and these are taken to the aircraft main distribution panel. Each supply is separately fused. With a 12-volt system 70 amp. minimum fuses are used and with a 24-volt, 60 amp. The recommended supply cables are 37-amp. cable in the 12-volt and 19-amp. cable in the 24-volt installation. The supply leads need not be of metal screened cable. The power units are, each, earthed through their fixing brackets.

109. The positioning of the resistance unit, type 47 or type 52 which is in the positive supply lead to the L.T. power unit is so arranged that its inclusion does not materially increase the length of leads. This resistance unit is kept away from anything which might be damaged by heat, and is never placed in the vicinity of anything inflammable. It is mounted vertically and in an open space so that the air may freely circulate through it. Setting instructions for the resistance units are incorporated later in the chapter.

110. The aerial switching unit, type J, or aerial plug board, which is used in place of it as a temporary measure, is positioned between the transmitter and the aerial lead-in points so that the "run" of the aerial leads is clean and short. It is easily accessible for operational purposes. Although aircraft may be fitted with plug boards upon delivery it is possible that selector switches may be installed at some future date. All leads, therefore, are made long enough to reach the appropriate sockets in the switch even though the switch is not fitted at the time.

111. With the aerial plug board in use, it is impossible to operate the transmitter unless certain connexions are made to the interlock plug E on the right-hand side of the transmitter. It is convenient to short-circuit the points 13 and 14, 15 and 16 of this plug by means of a "dummy" plug, type 175, suitably arranged. Alternatively, if a connector is being supplied between the four-pole plug and the selector switch (even if the switch is not fitted) shorting strips may be supplied with the connector and plugged into the socket at the end remote from the transmitter.

112. The aerial ammeter supplied for use on the H.F. RANGES is an external fitting and is positioned in the run of the H.F. aerial lead between the transmitter and the aerial switch or plug board. It is so mounted as to be read easily by the operator. The lower fixing bolt for this ammeter is attached to a bracket of insulating material such as wood or plastic and not to the metal structure. Care must be exercised to avoid breakdown.

113. Should the type 173, single-pole aerial sockets (117, fig. 18) engaging on the external ammeter and in the aerial selector switch be found to be weakly sprung and so liable to fall out due to vibration, they should be double-sprung, if possible, but otherwise they should be retained in position by a rubber band or a retaining block.

114. A small fixed condenser (63, fig. 18) is supplied for use with the aerial selector switch only and its function is to load the fixed aerial for M.F. operation. This condenser need not be installed in an accessible position. When an aerial board is used the lead and plug should be stored away.

115. All aerial leads between the transmitter and the selector switch and between the switch and the aerial lead-in points are of stout, high voltage cable such as Unispark 7 or an approved alternative. The run is kept as short as possible. These aerial leads are stood away from adjacent

metal work, particularly sharp points and angles, not only to reduce losses but also to avoid the possibility of brush discharge and breakdown. A minimum spacing of $1\frac{1}{2}$ in. between the conductor and the nearest metal work is provided. On medium frequencies the R.F. voltage between aerial terminals and earth may reach 6,000.

116. Fixed aerial lead-in insulators and trailing aerial fair-leads are installed with the possibility of the 6,000 volts in mind. The fixed aerial, though normally used for H.F. may be used for M.F. should the trailing aerial be lost.

117. To convert the R.T. version of the transmitter from "carbon" to "electro-magnetic" or *vice versa*, it is necessary to remove the chassis from its case and reverse a small plate (2, fig. 11) on the back of the instrument. This plate is held in position by six screws. The microphone connexions from the amplifier A.1134 to the input terminals of the transmitter are as for the transmitter T.1083, that is, T.1083 MIC+ and E. The spills 9 and 10 inside the A.1134 should be short-circuited.

OPERATION

118. Reference should be made to fig. 1 for assistance in the operation of the transmitter. The method of inserting valves (para. 99), the colour-coded controls applicable to the RANGES and the frequency coverage, has already been given. The appropriate aerials have been mentioned and the method of fixing the external aerial ammeter used on H.F. RANGES BLUE and RED can be found in para. 112. The ammeter M_2 mounted on the front panel is used for the YELLOW RANGE. The readings on the external ammeter will vary a great deal according to the transmitter frequency. A reading in the external ammeter, of M_2 and of the milliammeter M_1 , supplemented by the closing of the tuning indicator of the receiver when tuned to the same frequency as the transmitter, gives a degree of indication of the transmission.

119. As a rough indication of the performance of the transmitter, the accompanying standard record, TABLE H, is supplied. This record is arranged for the transmitter T.1154C, but on the common frequencies it is applicable to other types.

TABLE H
TYPICAL PERFORMANCE RECORD, T.1154C.
H.T. 1200 V—L.T. 6 V

Range	Frequency	Ae tap	Anode tap	C.W.		M.C.W.			R/T		
				Ae amps.	Total mA	Ae amps.	Total mA	Per-centage modulation	Ae amps.	Total mA	Per-centage modulation
BLUE 1	16.7 Mc/s	2	—	1.0	210	.7	155	70	As for M.C.W. As for M.C.W.		
	8.7 Mc/s	3	—	.7	200	.5	150	70			
BLUE 22	8.7 Mc/s	2	—	.8	165	.55	135	70	As for M.C.W. As for M.C.W.		
	4.5 Mc/s	7	—	.9	200	.65	145	70			
RED	4.5 Mc/s	5	—	1.6	210	.9	150	70	} Plng at "N" (see para. 63)		
	2.5 Mc/s	4	—	1.6	205	.9	145	70			
YELLOW High aerial	500 kc/s	1	30	1.55	200	1.0	155	70	1.0	155	70
	200 kc/s	14	21	1.0	155	.7	130	50	.7	130	50
YELLOW Low aerial	500 kc/s	8	33	1.7	200	1.0	155	70	1.0	155	70
	200 kc/s	17	23	.9	140	.6	120	50	.6	120	150

120. The M.O. tuning condensers C_2 , C_4 and C_{17} are each provided with "click-stops" enabling the dial to click into eight different positions corresponding to pre-set frequencies within the range. The output tuning condensers C_{15} and C_{16} are also so provided with "click-stops". The sliding core control of L_4 of the YELLOW RANGE output has no "click-stops". Each "click-stop" mechanism can be disengaged by a turn of a release knob (5), (6), (7), (8) or (9) fig. 1, enabling frequencies other than those of the eight "spot" frequencies to be used. The condensers C_2 and C_4 are calibrated in megacycles and C_{17} in kilocycles.

Setting-up the click-stops

AL 62 121. There are two types of "click-stop" mechanisms, the original type and an improved type. Operational procedure for the setting-up of the original type only is given here. The procedure for the new type "will be found in Appendix 2". The minimum spacing between adjacent selected frequencies is approximately as follows:—BLUE, every 25 kc/s; RED, every 10 kc/s; YELLOW, every 1 kc/s. To set up the original "click-stops" the following controls are used:—

- (i) Range switch, S_1
- (ii) Master switch, S_5
- (iii) M.O. condenser C_2 , C_4 or C_{17}
- (iv) Output condenser, C_{15} or C_{18} or sliding core control of L_6 and tap switch S_7
- (v) Tap switch S_3 , S_4 or S_6 .

Setting-up on H.F.

122. The letter (see fig. 14) to be used is selected and the pip with the same letter is engaged in the slot by rotating the dial. It is advisable to start with the last letter in alphabetical order on the particular range when commencing to set up. On RANGE 1, therefore, the letter H should be first selected. The screw (12, fig. 1), above the letter H embossed on the front of the dial, is then loosened and the dial is free to rotate with the click-stop pip marked with the letter H still engaged in its slot. RANGE 1 has been taken as typical and only the controls of that range are mentioned in these instructions.

123. The corresponding letter on the output dial of C_{15} is then engaged in its slot and the screw (13) above the letter H embossed on C_{15} is loosened. The tap switch S_8 is turned to the tap numbered 1 and the M.O. dial of C_2 to the desired frequency calibrated on its transparent scale (14). The switch S_5 is now turned to TUNE and the key K_1 depressed; the milliammeter M_1 should give a reading of something over 100 mA. The dial of C_{15} must now be turned to a position in which the needle of M_1 dips, indicating resonance of the output circuit.

124. The output should be tuned throughout its full 360 degrees since it is sometimes possible to obtain anode feed dip on M_1 at more than one position on the scale of the condenser C_{15} . The dip showing the lowest anode feed is the correct tuning point. The reason for the extra tuning point is that when the oscillator condenser is near to the centre of its frequency range, the commutator on the tuning condenser short-circuits part of the coil, giving two values of LC at which the tuning can be obtained; one, however, is the better.

125. Having obtained the correct tuning point, the switch S_3 is increased step by step, retuning C_{15} each time. The dip will not be so pronounced as the loading is increased, but S_3 should be raised until the meter just dips below the green line on the milliammeter scale, which represents approximately 65 mA. When altering the taps by S_3 , the key K_1 should not be depressed. If the switch S_6 is now put to C.W. the anode feed milliammeter M_1 should read approximately 100 mA. It is not always possible to adjust the feed exactly to this figure but if the figure is exceeded by more than 15 per cent. the next lower aerial tap should be used and C_{15} retuned.

126. The frequency should be checked in conjunction with a crystal monitor, type 2 (Stores Ref. 10T/11390) or by using the receiver as a wavemeter. The receiver R.1155 can be used for a frequency check, by setting the frequency range switch to the range in which the transmitter frequency occurs. The receiver is tuned to the required frequency, the master switch of R.1155 set to OMNI and the volume control R_8 set to minimum. Then, with S_5 at TUNE, K_1 should be depressed and C_2 turned until closure is indicated by the tuning indicator of R.1155. Should the frequency be too high or too low, re-adjust C_2 . Re-check with the tuning indicator of R.1155.

127. Finally the locking screw (12) in the white disc below the letter H embossed on the M.O. tuning control dial C_2 should be tightened. The M.O. click-stop H is now set up correctly for the frequency originally selected. The output condenser C_{15} should now be trimmed for dip on M_1 and, with S_5 in the TUNE position, this should occur on the green mark. The locking screw for the letter H should now be locked and the operation of setting-up is completed. A calibration mark will be found on the click-stop lever cover (16). The letter "H" should be marked in pencil on the white scale to coincide with this calibration mark, so that the dial may be rapidly turned to this position when required.

128. The letter H should also be marked on the dial of the condenser C_{15} in the same way. On the calibration card (2), against the letter H, should be noted in the space (17) the frequency to which the click-stop has been set and also the number to which the tap switch has been tuned for correct loading. When using inter-tuning between the transmitter and R.1155, the note in the telephone will not alter when the transmitter and receiver are tuned to the same frequency.

129. To check against a crystal monitor, the correct frequency crystal must be selected and the telephones removed from the transmitter and plugged into the monitor. The M.O. dial of C_2 should be adjusted very slowly until zero beat is heard in the telephones. The locking screw adjacent to the letter H may then be tightened and the M.O. click-stop is then set. The dial of C_{15} should then be adjusted very slowly and the position of lowest dip on M_1 obtained. This should be around the green mark on M_1 . No variation in the tap position of S_3 should be necessary. The screw above the letter H is then tightened.

Setting-up on M.F.

130. Normally the YELLOW RANGE is used in conjunction with the trailing aerial, but to facilitate the setting-up on the ground, of frequencies within the range, the aerial selector switch should be adjusted to the M.F. ON FIXED AERIAL position, before commencing the initial tuning of the M.O. circuits. The output circuit can only be set up in flight when the trailing aerial T.Ae is reeled out. The procedure for setting-up click-stops on the M.O. is similar to that used for the H.F. ranges, the dials being of identical design.

131. Select the letter X, engage the correct pip X and loosen the screw above X on the M.O. dial. Then turn the M.O. dial to the position in which the required frequency coincides with the mark on the click-stop cover. The output circuit is set up as indicated below. The tap switch S_7 is set to 17, S_6 to 18 and S_5 to TUNE, the key K_1 is depressed and the reading on M_1 noted. This reading should be higher than the green mark if the output circuit is not in tune with the M.O. circuit.

132. The tap switch S_7 should be turned one tap at a time until the reading on M_1 is reduced. Each time a change in the aerial taps switch S_7 is made, the key must be released and for each adjustment the knob of L_6 must be rotated from MIN to MAX for each tap until a minimum reading is shown on M_1 . The dip in the anode current will occur at a low reading of M_1 and the anode tap switch S_6 should be increased step by step adjusting back on L_6 for minimum reading until M_1 reads on the green line. It is advisable to trim L_6 after the adjustment.

133. The M.O. and output of the M.F. RANGE being in tune, the frequency should be checked by a crystal monitor. The procedure outlined in para. 129 should be adopted and when zero beat is obtained, the screw above the letter X on the dial of C_{17} should be tightened.

Tuning M.F. output circuit on trailing aerial

134. When using the trailing aerial the M.O. click-stops remain unaltered, but the tap switch adjustments on both S_6 and S_7 and the setting of the control of L_6 will be found to differ from those obtained when setting-up on fixed aerial. This is due to the increased capacitance of the aerial system. The method of tuning the output circuit is the same as that employed for tuning a fixed aerial. The aerial selector switch should, however, be turned to NORMAL.

135. A very slight variation of the setting of the control of L_6 may be noted with different speeds of travel and varying weather conditions. This should always be checked prior to transmission. When the correct settings of the output controls on the trailing aerial have been found, the letters coinciding with those of the click-stop M.O. dial should be entered on the white scale around the control of L_6 . Both tap switch numbers should be marked with the frequencies on the calibration chart (2) opposite the letter engaged.

Setting-up frequencies other than those set up on click-stops

136. Should it be necessary to use a frequency in flight which has not been set up on the ground, a release device is fitted to both the M.O. and the output dials. This release enables the dials to be rotated freely without disturbance of the click-stops. The release controls are annotated (5), (6), (7), (8) and (9) on the illustration fig. 1.

137. The calibration of the M.O. dials should be used as a guide to the frequency required, and the output dial should be freely rotated for dip in the manner similar to that used in the initial setting. Before commencing to tune, the control of the tap switch must be set at tap 1. If transmissions are taking place on the desired frequency, R.1155 should be tuned to them, the dial setting noted and the inter-tune method employed between transmitter and receiver. At the conclusion of transmission the click-stops can be re-engaged by turning the M.O. release and turning the M.O. and output releases to the ON position.

Fine adjustment of BLUE and RED RANGES

138. Small levers annotated (3) and (4) on fig. 1 will be found at the right-hand side of C_2 and C_{11} . The purpose of these is to give fine adjustment of the frequencies to which the click-stops are set. With change of temperature, the setting-up of the click-stops signals may be reported as

slightly off tune. In other circumstances it may be necessary to use this adjustment to vary the frequency slightly when interference is experienced at the receiving station. The levers are capable of varying any click-stop frequency by plus or minus 0.1 per cent. The correct position for the levers is the second position from the bottom, the frequency being decreased by an upward movement. It will be appreciated that this entails the provision of one frequency increase and two frequency decrease positions. With increases in altitude and with reduced temperature, the M.O. frequency will tend to increase and under conditions of extreme heat frequency will tend to decrease.

Aerial matching on RED RANGE

139. The pre-set adjustment of the anode tap in the output circuit coil, is provided to enable the aerial circuit to be correctly loaded when using this transmitter on a very small aerial. This anode tap is located on the right-hand side of the power amplifier valve compartment. It is necessary to remove the valves to alter its position. To alter the tap position, the lead from terminal 1 behind the transmitter panel should be disconnected and re-connected to terminal 2. This special tap position should be used when it is not possible to bring the reading on M_1 up to the green mark in the TUNE position of S_5 , even with the tap switch S_4 on 9.

140. On the T.1154C to the left of the aerial tap switch a reversible three-point socket N-X will be found. An arrow on the panel points to one or the other of these letters depending upon which way this socket is inserted. The normal position is with the arrow point to N. In the reverse position a condenser of 0.0003 μF is connected across the aerial end of the circuit and earth. This enables highly resistive or inductive aeriels to be loaded up satisfactorily. Such aeriels may be encountered when working H.F. into the trailing aerial.

Routine—normal communications

141. Before commencing to transmit, all plugs and sockets should be checked to ensure that secure contact is being made. When not engaged in two-way communication, the switch S_8 should always be at STAND-BY. Having set the aerial selector switch to NORMAL, or alternatively, when using the aerial plug board FIXED AE to H.F., TRAILING AE TO M.F., the switch S_8 should be turned to STAND-BY. The volume control of R.1155 should now be turned until receiver noise is heard and the receiver master switch placed in the OMNI position. The tuning indicator of R.1155 will now show a green light. The receiver range switch should now be turned to the required range and the instrument adjusted roughly to the required frequency by the outer knob, fine tuning being achieved by the inner knob. When working C.W. the heterodyne-switch should be turned ON.

142. The transmitter click-stops having been previously adjusted, the calibration card on the front of the transmitter should now be consulted and the appropriate colour, RED, BLUE or YELLOW and the letter noted. The switch S_1 should now be turned to the range colour. When transmitting on BLUE or RED RANGES ensure that the correct lever (3, or 4, fig. 1) is positioned at the second marking from the top of the scale. Adjust the master oscillator dial of the correct colour to the required letter which is marked in pencil on the edge of the dial. Click into position.

143. The similarly coloured output dial should now be adjusted to the appropriate letter and the tap switch number, pencilled against this letter, should be noted. When transmitting on YELLOW RANGE a note should be made of the two numbers pencilled against the letter. On BLUE and RED the control of S_3 or S_4 should be adjusted to the number noted and on YELLOW the control of S_6 and S_7 should similarly be adjusted.

144. The master switch S_5 should be turned to TUNE. The key K_1 should now be depressed and a reading taken of the feed current on M_1 . The needle should be on the green line or only very slightly below it. The key should now be released and S_5 turned to C.W. The key should again be depressed and, when using BLUE or RED the external aerial ammeter should indicate. The milliammeter M_1 should read approximately 100 mA. When transmitting on YELLOW there should be a reading on M_2 but not on the external ammeter. On this RANGE the reading on M_1 should not increase above 100 mA. when the switch is placed in C.W. position. Whilst transmitting on either the H.F. or M.F. ranges, it should be noted that a 1,200 cycles per second side-tone note should be heard in the telephones, that "listening through" with K_1 released can be tested on signals or receiver mush, that the tune indicator on R.1155 will flicker with dots and dashes if the receiver is tuned to the same frequency as the transmitter and that the instrument needles on the transmitter should flicker during dots and dashes.

145. If it becomes necessary to correct the spot frequency setting on the BLUE or RED H.F. RANGES, very slight adjustment can be effected by moving the levers, annotated (3) and (4) in fig. 1, which are situated at the right-hand side of the click-stop mechanism. An upward movement reduces the frequency slightly; downward movement increases frequency.

M.C.W. transmission

146. To obtain M.C.W. transmission, switch S_5 should be turned to M.C.W. It will be found that the feed current as read on M_1 is the same as when S_5 is in the TUNE position, that is at the green mark in the milliammeter scale.

R/T transmission

147. When using transmitters fitted with R/T facilities the master switch S_5 is turned to the R/T position for this type of transmission. The setting-up procedure is exactly as for C.W. except that the switch S_5 must be turned to R/T. Two sockets are provided below the left-hand valve compartment on the front panel to accommodate the microphones. In order to connect the transmitter to the aerial, it is necessary, when transmitting on R/T, to keep the morse key depressed. The feed current reading on M_1 will be on the green mark.

148. Either carbon granule or electro-magnetic microphone may be used, but with the latter it is necessary to employ the amplifier A.1134, the output of which is connected to the microphone sockets on the transmitter. Control of R/T transmission can be exercised by the pilot and second pilot by the provision of a switch connected in parallel with the morse key. Before this facility can be used, however, switch S_5 must be in the R/T position.

Emergency working

149. Should it be necessary to utilize the BLUE or RED RANGE for transmission on the trailing aerial, due to the fixed aerial having been lost or put out of action, the aerial selector switch should be turned to the position H.F. ON TRAILING. In installations where the aerial plug board is used the positions TRAILING AE TO H/F, FIXED AE TO EARTH should be employed. Note the required frequency which is entered on the panel on the front of the transmitter and set up the master oscillator controls BLUE or RED as previously detailed. Turn the correspondingly coloured tap switch to No. 1 tap. Release the output dial by turning the small release handle (8) or (9) fig. 1 to OFF.

150. The output circuit should then be retuned as indicated in paras. 124 to 125. The transmitter is now ready for use.

151. On certain frequencies with the T.1154C the trailing aerial may be used for transmission on the H.F. RANGES when it is required to increase the range of transmission. This may be found to be useful when extra range on R/T is required. Contrary to the usual practice, the whole length of aerial should be reeled out. It will be found that the positions for the power amplifier tuning condenser and aerial tap will be in different positions from those found for the normal fixed aerial. The aerial current under these conditions will vary over wide limits and the indications of the feed meter should be taken as a means of checking radiation.

152. In certain circumstances it may be necessary to restrict the range of C.W. transmissions. In order to fulfil this requirement, the transmitter may be used in the TUNE position, which decreases the power output to about 25 per cent. Both H.F. and M.F. transmission on C.W. may be effected in this manner.

153. Due to valve failures or shortage of spares, circumstances may arise in which only one V.T.104 valve is available for use in the power amplifier stage. The transmitter will function using one valve only, but the following points should be remembered:—

- (i) Free the power amplifier click-stop tuning.
- (ii) Readjust the power amplifier tuning dial and aerial taps.
- (iii) When setting up, load the power amplifier to as nearly as possible on the green line in TUNE position.
- (iv) The single valve will then be overloaded and should be replaced as soon as possible.
- (v) Always remove the faulty valve when using a single valve in the power amplifier stage.

154. Due to valve failure, or shortage of spares, circumstances may arise in which no spare M.O. valve is available. The transmitter will function, on C.W. only, without the modulator valve which may be used as an M.O. valve by inserting it in the M.O. socket. No side-tone will be available when working in this condition.

Interference between H.F. and M.F. aeriels

155. This condition may occur when the M.F. circuit, connected to the trailing aerial, is tuned to a sub-multiple of the H.F. frequency being used on the fixed aerial. As an example, the M.F. may be tuned to 500 kc/s and the H.F. circuits working into the fixed aerial are tuned to 5 Mc/s. Under these conditions the M.F. is tuned to one-tenth the H.F. frequency.

156. Indications of this effect take the form of a considerable reduction of H.F. aerial current, with normal anode current indications in the TUNE and C.W. positions but low "off tune" current. The radiation in these circumstances is not greatly altered. Proof that this effect is taking place can be shown either by disconnecting the M.F. aerial plug on the transmitter or by altering the M.F. power amplifier tuning on the tap switch 1 to 17.

H.F. aerial current

157. When working on H.F. the aerial current may vary between no indication at all on parts of the tuning range and full scale deflection of the H.F. aerial ammeter on other parts of the tuning range. The variations are due to the relationship between aerial length and the frequency in use, and the radiation will be, irrespective of aerial current, approximately equal.

158. For guidance, it should be understood that the aerial current will be at a maximum when the aerial length is equal to $\frac{\lambda}{4}$ or $\frac{3\lambda}{4}$ and at a minimum when the aerial length is equal to $\frac{\lambda}{2}$ or λ being operated.

159. When tuning on H.F. always set up the power amplifier circuits so that the anode current dips to the green mark on the milliammeter in the TUNE position and ignore the aerial current readings.

M.F. on fixed aerial

160. The condition noted as M.F. on FIXED, means that the trailing aerial has been lost or is out of action. In these circumstances the aerial selector switch should be turned to M.F. ON FIXED or alternatively, when using the aerial plug board, the positions FIXED AE TO M.F., TRAILING AE TO EARTH should be used. The receiver volume control should be increased to maximum, due to the fact that the aerial pick-up is decreased on account of the small aerial. The master oscillator should be set up as previously described and the two tap switches S_7 and S_8 turned to 17 and 18 respectively.

161. The switch S_5 is positioned at TUNE and the key is depressed. The YELLOW output knob of L_3 is rotated from maximum to minimum and, at the same time, it should be noted if the needle of M_1 dips. In the event of no dip, the tap switch S_7 should be reduced one tap at a time until a sharp dip occurs on M_1 . The key should be released between each adjustment of S_7 , and the correct tuning checked each time by rotating the YELLOW control of L_3 . Slight variation only should occur.

162. The tap numbers on S_7 should be increased one step at a time, retuning knob of L_3 for minimum feed at each step until the needle of M_1 is at the green mark. The switch S_5 should then be turned to C.W. and the key depressed. The aerial ammeter M_2 should now read between 1.5 and 3 amps. and the needle of M_1 should be on the RED portion of the scale. The instrument is now ready for transmission.

163. In heavy static or thunder, the fixed and trailing aeriels should be earthed. This condition is met by turning the aerial selector switch to EARTH. With the switch in this position, the transmitter is automatically switched off. When using the aerial plug board the position FIXED AND TRAILING AE TO EARTH should be used. The master switch S_5 should be at STAND-BY or OFF.

PRECAUTIONS AND MAINTENANCE

164. The equipment may be ground tested on the BLUE and RED H.F. RANGES by setting the aerial selector switch to NORMAL.

165. For M.F. transmission on the ground, the aerial selector switch must be turned to the position M.F. ON FIXED AERIAL and the switch S_1 set to YELLOW.

166. When switching S_5 to TUNE, should no reading appear on M_1 after depressing the key, the switch should be turned to OFF. If the H.T. power unit has been functioning normally the H.T. fuse F_1 should be inspected. The output brushes of the H.T. unit may be inspected by removing the cover. If the H.T. power unit fails to run up when the switch S_5 is turned to TUNE, check for correct positioning of the aerial selector switch. After switching OFF S_5 the L.T. fuses on the aeroplane electrical switchboard should be checked and the input brushes of the H.T. unit inspected.

The magnetic relay, type 85

167. Should the magnetic relay fail to function, the blade tips and stiffeners should be inspected to see that they are approximately in line. The pressure between blades and stiffeners can be checked by a relay gauge but on no account should the stiffener strips be bent to facilitate adjustment. Instructions for taking pressure by means of a P.O. spring balance and the correct gap between the contact tips will be described in the appropriate section of AIR PUBLICATION 1095.

168. The pressure on the gold-silver contact tip which just lifts the blades off their stiffener should be within the range 20 to 30 grams. The armature plates should be firmly screwed in position and the holding bolts securely locked and soldered. In the "just made" position, the centre of the moving contact should be within $\frac{1}{32}$ in. radially from the centre of the fixed contact. The relay spindle should roll freely from side to side under its own weight when the relay is tilted.

169. In either of the closed positions of the magnet structure a small air gap of 0.002 in. to 0.007 in. should remain between the armature plate and the central leg of the yoke. The insulation should withstand a 500-volt megger test between windings and frame and give a resistance of greater than 1 megohm. The overall characteristics of the relay may be checked by measuring the minimum voltage which, applied to each coil in turn, will just cause the relay to close. This is shown in TABLE J.

TABLE J

Coil	Terminals	Maximum value permissible to cause relay to close
A	3 and 4	4 volts
B	1 and 2	2.2 volts
C	2 and 5	1.85 volts
D	2 and K	3.2 volts

170. A transmitter trouble location chart in fig. 19 includes a diagram of the magnetic relay, type 85 with various relevant figures such as gap apertures.

Click-stops

171. Should any question arise relative to the accuracy of the click-stop frequency settings the click-stop mechanism may be tested in the following manner. Engage each of the stops in turn and slack off the corresponding locking screw, the remaining locking screws being tight. It is important that, with the locking screw slackened off, it should be possible to rotate the turning condenser freely, leaving the click-stop engaged in its lever. This applies to all the click-stop mechanisms on both the M.O. and the output circuit controls.

172. Set the transmitter up on some pre-determined frequency and lock the click-stop plate in position. Tune in this frequency on the crystal monitor to enable a beat note to be heard in the receiver R.1155. Having set up the frequencies as above, disengage the M.O. condenser click-stop and re-engage it a number of times, approaching from either direction. Each time the click-stop is engaged, the beat note should be checked against the crystal monitor. The transmitter should be allowed to run with the key depressed for at least five minutes so that any results should not be confused with initial drift.

173. The difference between the highest and the lowest of the frequencies measured should not be more than $1/3000$ of the fundamental frequency of the transmitter on the BLUE and RED RANGES and not more than $1/1000$ on the YELLOW RANGE.

Frequency change

174. When moving the master switch S_5 from the TUNE to the C.W. position a small change of frequency will be observed. This should not be greater than 3 kc/s on any RANGE.

Condenser C_{29}

175. In certain instruments a 0.01 μF condenser C_{29} , type 440 (Stores Ref. 10C/10629) is fitted between H.T. negative and earth. As it has been found that the necessary conditions are satisfied when C_{29} is omitted from the circuit, instructions have, therefore, been issued to Units to remove the condenser which is situated at the rear of the transmitter and mounted on the base of the chassis. The sequence of operations is as follows:—

- (i) Remove the transmitter chassis from its case.
- (ii) Identify the bank of condensers, at the rear of the transmitter, mounted on the base of the chassis and situated between LFC_3 and LFC_2 . The condenser C_{29} is one of this bank.
- (iii) A lead connected between the spill of this condenser nearer to the rear of the transmitter and the resistance R_{24} (see fig. 11) is disconnected and removed. The condenser C_{29} is not shown in fig. 11.
- (iv) Replace the transmitter in its case.

Filament resistances R_{30} , R_{31}

176. Earlier versions of the transmitter were not fitted with resistance in the filament circuit of the V.T.104 power amplifier valves V_2 and V_3 . Later issues have been so fitted, but to provide for action by Units, instructions were issued in leaflet form. The maker's modification to provide for the switching of the resistance is effected on a switch wafer of S_5 . The parallel resistances R_{30} and R_{31} are brought into circuit in STAND-BI only. In other positions they are short-circuited. The resistances R_{30} and R_{31} constitute the resistance unit, type 164 (Stores Ref. 10C/4606). Where the modification is done by the service units the following is the sequence of operation for the R.T. model.

- (i) Remove the valves from the transmitter.
- (ii) Remove the transmitter from its case, placing it inverted, on the bench with the panel to the front. Identify the valve holder compartment (*see* fig. 25c).

Mounting of filament resistances

- (iii) Replace the two screws at "X" by two $\frac{5}{8}$ in. long 6 B.A. cheese-head brass screws.
- (iv) Fit the resistance unit, type 164, to these screws and secure by means of 6 B.A. washers and nuts. Coat the nuts and projecting ends of the screws with shellac varnish.

Mounting of filament switch

- (v) Slacken off the screws of the cam unit assembly and separate the two parts. Place the cam unit on the switch rod as shown with the section containing the two screws underneath. Tighten sufficiently to retain the unit on the switch rod.
- (vi) Fit the switch unit assembly to the valve holder screw A. The switch unit assembly has a tapped hole to accommodate the screw which should be coated with shellac varnish before fitting.
- (vii) Set S_5 to the position engraved "STAND-BI".
- (viii) Slide the cam unit into position so that the indent in the switch arm blade engages centrally in the groove of the semi-circular cam. Tighten the fixing screws of the cam unit assembly, and coat with shellac varnish.
- (ix) Rotate the switch handle and check that the contacts of the switch unit assembly are closed at all positions except "STAND-BI". It is also important to check that the contacts are open when the switch handle is rotated to the "STAND-BI" position from either direction.

Modification to wiring of transmitter

- (x) A lead connects from pin No. 6 of the 8-pin plug, type 212 (Stores Ref. 10H/438) to the positive heater socket of the adjacent V.T.104 valve holder. Disconnect this lead at the valve holder pin and transfer it to the front spill of the switch unit assembly.
- (xi) From this latter tag connect a length of No. 18 s.w.g. tinned copper wire encased in Grade E insulating tubing to one of the lower soldering tags of the resistance unit, type 164. This lead is to pass under any components on the way.
- (xii) Solder an insulated lead between the heater socket referred to in para. (x) and the free soldering tag of the switch assembly unit.
- (xiii) In certain transmitters type T.1154B a lead which passes through the elongated hole in the back of the compartment connects to a V.T.104 heater socket as shown. This lead is to be disconnected at the heater socket and re-connected to the lower soldering tag of the resistance unit, type 164.
- (xiv) Connect a suitably insulated lead between the upper soldering tag of the resistance unit, type 164, and the V.T.104 heater socket as shown.
- (xv) Replace the transmitter in its case and replace the valves and front panel.

For the C.W. M.C.W. d. The following is the sequence of operations:—

- (a) Remove the valves from the transmitter.
- (b) Remove the transmitter from its case, placing it inverted on the bench, with the panel to the front. Identify the valve holder compartment (*see* fig. 25d).
- (c) Replace the two screws at "Y" by two $\frac{5}{8}$ in. long 6 B.A. cheese-head brass screws.
- (d) Fit the resistance unit, type 164, to these screws and secure by means of 6 B.A. washers and nuts. Coat the nuts and projecting ends of the screws with shellac varnish.

Mounting of filament switch

- (e) Cut away, as near to the valve holder sockets as possible, the two leads as shown between the heater sockets of the valves type V.T.104 and V.T.105. (Do not attempt to unsolder these leads).
- (f) Slacken off the screws of the cam unit assembly and separate the two parts. Place the cam unit on the switch rod as shown with the section containing the two screws underneath. Tighten sufficiently to retain the unit on the switch rod.
- (g) Fit the switch unit assembly to the valve holder screw A. The switch unit assembly has a tapped hole to accommodate the screw which should be coated with shellac varnish before fitting.
- (h) Set S_5 to the position "STAND-BI"
- (i) Slide the cam unit into position so that the indent in the switch arm blade engages centrally in the groove of the semi-circular cam. Tighten the fixing screw of the cam unit assembly, and coat with shellac varnish.
- (j) Rotate the switch handle and check that the contacts of the switch unit assembly are closed at all positions except "STAND-BI". It is also important to check that the contacts are open when the switch handle is rotated to the "STAND-BI" position from either direction.

Modification to wiring of transmitter

- (k) Connect a length of No. 18 s.w.g. tinned copper wire, encased in Grade E insulating tubing between the transmitter earthing tags B and C as shown in fig. 25, and passing beneath the switch rod.
- (l) A lead connects from pin No. 6 of plug, type 212 (Stores Ref. 10H/438) to the heater socket of the adjacent V.T.104 valve holder. Cut away a short portion of this lead at the valve socket ensuring that the part of the lead to which two existing leads are connected, remains soldered to pin No. 6 of the plug.
- (m) Connect an insulated lead between the remaining portion of the lead referred to in para. (xii) and the soldering tag nearest to the panel of the switch unit assembly.
- (n) From this latter tag, connect an insulated lead to the lower soldering tag on resistance unit, type 184. This is to pass beneath any components on the way.
- (o) Connect an insulated lead between the lower soldering tag of resistance unit, type 164, and the positive heater socket of valve, type V.T.105 as shown.
- (p) Connect an insulated lead between the upper soldering tag of resistance unit, type 164, and the positive heater socket of valve, type V.T.104 as shown.
- (q) Connect an insulated lead between the V.T.104 valve heater socket referred to in para. (xii) and the free soldering tag of the switch unit assembly.
- (r) Replace and secure the transmitter in its case. Replace the valves and front panel.

Resistance R_7

177. Some issues of the resistance R_7 , type 1045 (Stores Ref. 10C/1046) have the centre tapping clips of such a length that in certain circumstances of rotation of the resistance the clip might touch the case of the transmitter. Instructions for remedial measures have been issued in the leaflet A.P.1186/A.139—W. The modification consists in cutting off the surplus length of clip. Care should be taken not to fracture the porcelain tube and to ensure that the screw and nut securing the lead to this clip are still tight after the cutting operation.

M.F. RANGE aerial tuning coil

178. In certain cases the rack-retaining pin on the iron core of the M.F. RANGE aerial tuning coil of the transmitter has become loose. This defect can be remedied in the manner described in the leaflet A.P.1186/A.140—W. The following is the sequence of operations:—

- (i) Remove the screws on the top, bottom and sides of the transmitter securing cover to the transmitter. Withdraw the transmitter.
- (ii) Identify the M.F. aerial tuning coil control knob, shown as L_8 on fig. 1. Remove the control knob by unscrewing the single fixing screw (18) at its centre.

- (iii) Remove the core retaining strip screwed to the coil former and situated at the back of the transmitter (3, fig. 11). On removing the fixing screw it may be found to be made from an insulating material, if this is the case and it is damaged or broken, it is to be replaced by a 2 B.A. brass screw, cheese head, $\frac{3}{8}$ in. (Stores Ref. 28C/2066).
- (iv) Turn the control spindle (1, fig. 11) in a counter-clockwise direction until the rack is out of mesh with the skew gear wheel. Withdraw the core and rack from the back of the coil.
- (v) Bind linen thread No. 40 (Stores Ref. 32B/456) tightly around the spindle over the pin securing the rack to the core. This should extend about $\frac{1}{8}$ in. on either side of the pin.
- (vi) Cover the linen thread with bakelite or shellac varnish (shellac in methylated spirits Stores Ref. 33A/172).
- (vii) Turn the control spindle until the driving pin at the front panel end is horizontal.
- (viii) Insert the core and rack to the skew gear wheel. The rack will require guiding into position and this can be accomplished from the right-hand side of the transmitter. Turn the control spindle clockwise applying slight pressure to the core to ensure that the rack is drawn into mesh.
- (ix) Replace the control knob and check to ensure that the core travels the whole length of the coil with complete rotation of the control knob between stops. In the fully counter-clockwise position of the control knob, the core should be approximately $\frac{1}{32}$ in. below the back edge of the end of the coil former.
- (x) Remove the control knob. If the core does not travel the whole length of the coil, rotate 180 deg. and replace.
- (xi) Replace the core retaining strip.
- (xii) Replace the transmitter in the screening cover and secure with the screws previously removed.

Transmitter case screws

179. It has been found that the "coin-slot" 4 B.A. screws securing the transmitter to the case are apt, by continued use, to strip their threads. Units have been instructed to replace at the first opportunity, any such stripped screws by the special replacement screws, case securing, coin-slot, $\frac{3}{16}$ in. Whitworth (Stores Ref. 10D/590), demanded from the appropriate Maintenance Unit. Before fitting the new screws, the holes have to be tapped out to $\frac{3}{16}$ in. Whitworth.

Checking after adjustments

180. When replacing a transmitter, the adjustment of the pre-set anode tap should always be checked and set to the position found to be suitable for the aerial system of the aircraft. When replacing a transmitter the position of the carbon electro-magnetic link should be checked either by examination of the link, or by an ohm-meter test at the microphone terminals as outlined in the D.C. resistance tests.

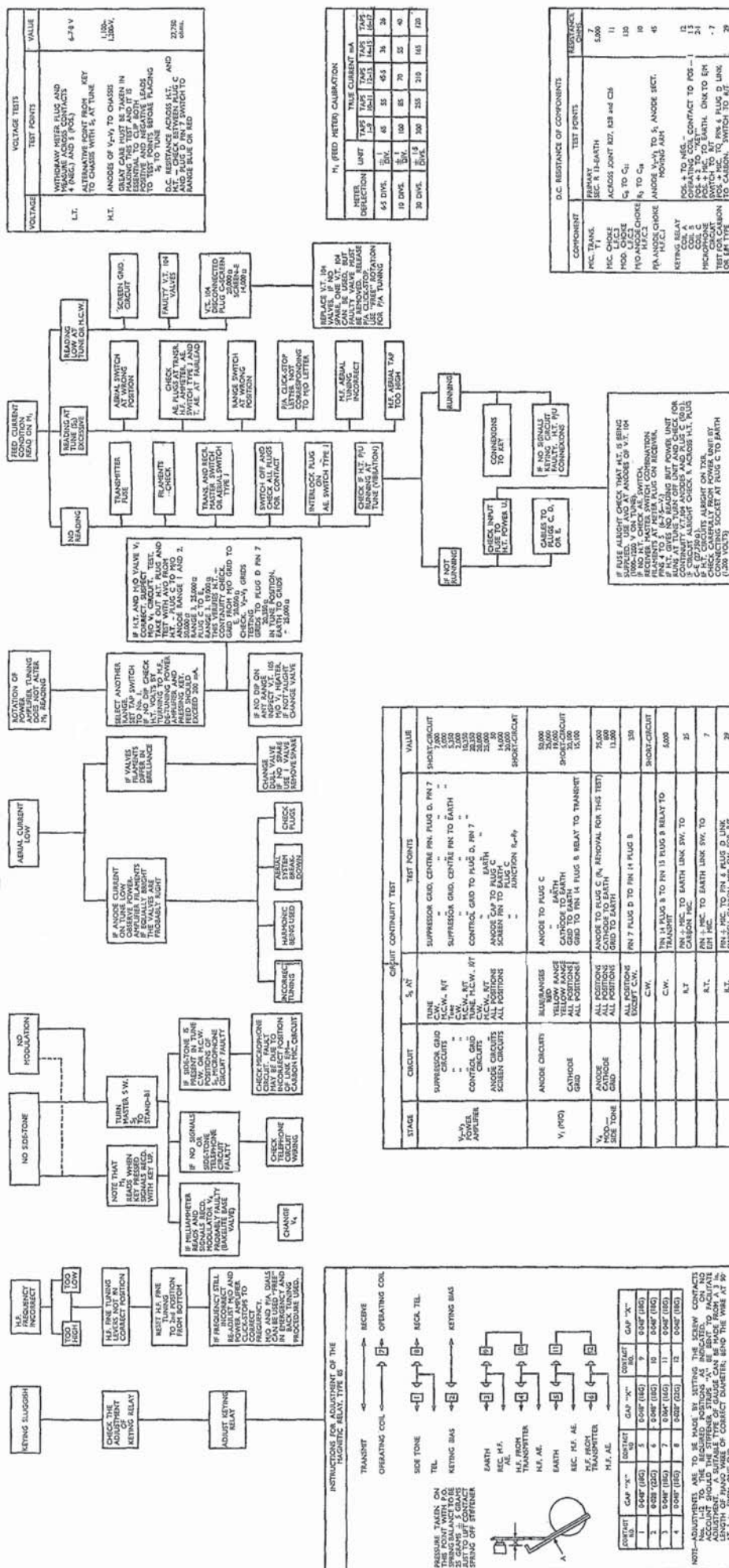
THE POWER SUPPLIES

181. The power supplies for the T.1154-R.1155 equipment, when air-borne, are derived from two rotary transformer power units, one for transmitter H.T. and the other for receiver H.T. and all L.T. requirements. The power units are driven by 12-v. or 24-v. accumulators associated with the engine-driven generator of the aircraft. At the introduction of the equipment the five power units which are listed on the TABLE in para. 182 were specified for use but certain modifications to these units have been made to reduce the heavy drain upon the accumulators.

182. The accompanying TABLE K gives the electrical characteristics of all airborne power units, together with the types of rotary transformer used and other relevant details.

TABLE K
ORIGINAL POWER UNITS

Type	32	33	34	34X	35
Stores Ref. No.	10K/17	10K/18	10K/19	10K/61	10K/20
Rotary, transformer type	28	29	30	30X	31
Stores Ref. No.	10K/21	10K/22	10K/23	10K/63	10K/24



TROUBLE LOCATION CHART

TABLE K (contd.)

Type	32	33	34	34X	35
Weight, lbs.	30 $\frac{1}{4}$	29	28 $\frac{1}{2}$	28 $\frac{1}{2}$	27 $\frac{1}{2}$
Nominal rating, watts	240	240	115	115	115
Ambient temp. range	- 40° C. to + 45° C.	- 40° C. to + 45° C.	- 40° C. to + 45° C.	- 40° C. to + 45° C.	- 40° C. to + 45° C.
Maximum ripple per cent. R.M.S.	1 on L.T.	1 on L.T.	1 H.T. 2 $\frac{1}{2}$ L.T.	1 H.T. 2 $\frac{1}{2}$ L.T.	1 H.T. 2 $\frac{1}{2}$ L.T.
Voltage reg. n per cent.	18	18	20 H.T. 25 L.T.	20 H.T. 25 L.T.	20 H.T. 25 L.T.
Efficiency per cent. better than	60	60	50	50	50
<i>Input voltage—</i> Nominal	12	24	12	14	24
Actual	13.2	27.4	10.3	14	18.5
Rated outputs D.C.	1,200 v. 200 mA	1,230 v. 200 mA	217 v., 110 mA 7 v., 13 A.	245 v., 110 mA 8.1 v., 13 A.	217 v., 110 mA 7 v., 13 A.

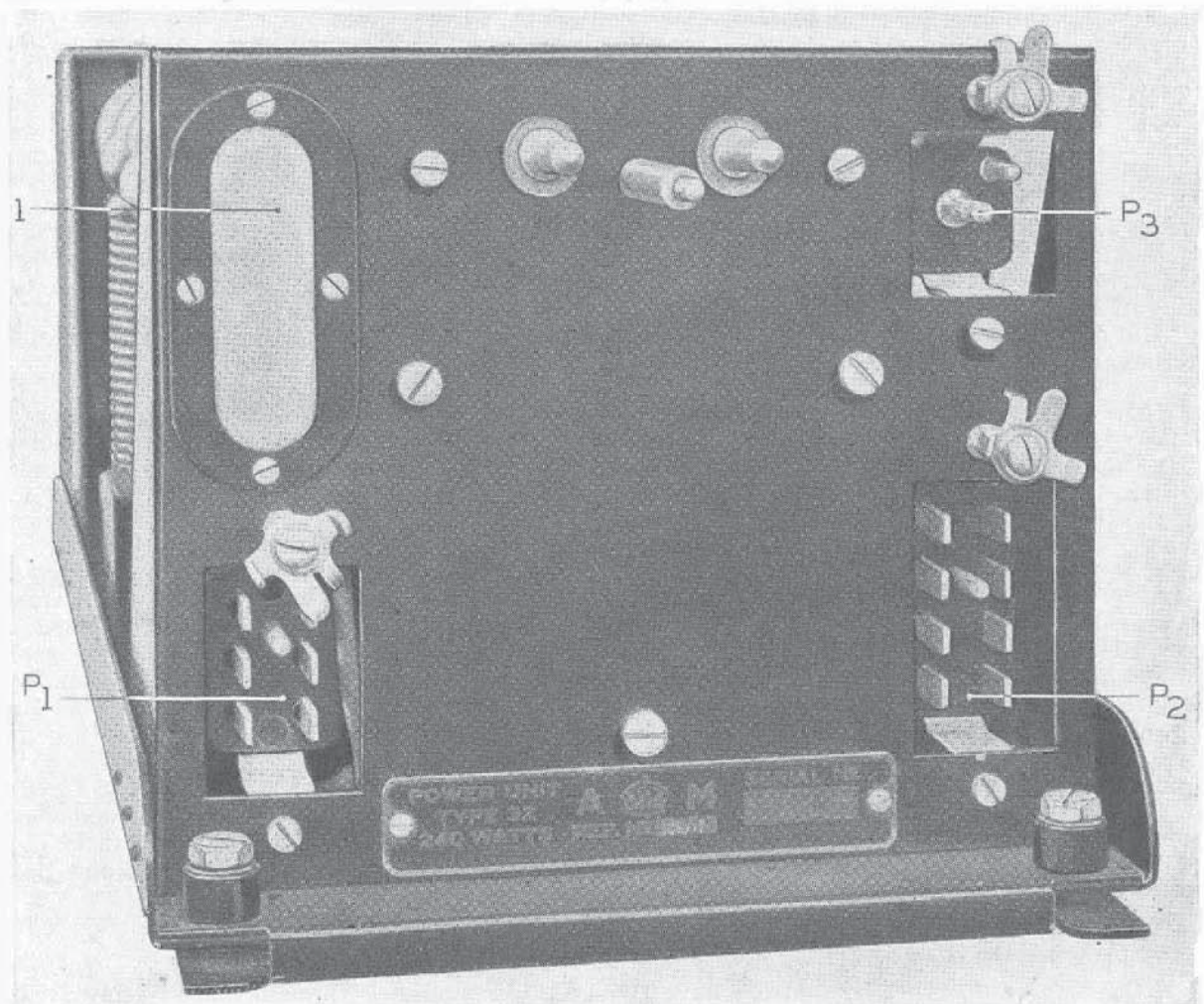


FIG. 20.—POWER UNIT, TYPE 32

183. In certain aircraft the L.T. power was derived from the power unit, type 34X. The input was "boosted" by switching IN and OUT of circuit a 2-volt 20-Ah accumulator in step with the OFF and ON charge condition of the main engine-driven generator. This condition differed from that applying to the type 34 which has a resistance unit, type 47 (*see* para. 196) in series with the input, this resistance being switched IN and OUT of circuit in step with the OFF and ON charge condition of the generator. The type 34K may now be regarded as obsolescent.

184. A leaflet A.P.1186/M detailed the procedure to be adopted when replacing the type 34X by a type 34 power unit. For record purposes the sequence of operations is herein repeated:—

- (i) Disconnect and remove the 2-volt "boost" accumulator from the aircraft.
- (ii) Mount the resistance unit, type 47 in a suitable position on the airframe. The site chosen should be a well-ventilated one and should be as close to the run of the existing leads as possible. The resistance unit is to be secured to the airframe by means of 2 B.A. screws, nuts and washers.
- (iii) Connect the resistance unit, type 47, a switch, type 378 and the power unit, type 34 in the manner shown on the diagram included in fig. 25a.
- (iv) Remove and reverse the switch label engraved "Boost cell OUT-IN". Engrave on the blank side the inscription "Resistance OUT-IN" ensuring that the words "OUT" and "IN" correspond to the setting of the switch which removes and inserts the resistance, type 47 in the L.T. supply lead. The considerations applicable to the critical setting of the resistance are dealt with later in this chapter.

185. Certain conditions imposed a modification of the power units and the two-step system of starting, originally arranged, has been eliminated. The modification merely consisted in permanently screwing up the relay contact adjustment of the single contact winding that when the relay armature is actuated the full input voltage is applied straight across the motor. The initial transitory starting voltage becomes therefore of the order of 100 amps. in the 12-volt type and 70 amps. in the 24-volt type instead of about 2 amps. above the normal running current. This running current is approximately 12-volts, 32 amps. or 24-volts, 16 amps, for the H.T. machine and 12-volts, 24 amps or 24-volts, 12 amps for the L.T. machine.

186. The illustration of fig. 20 shows a front view of a power unit. Interior views are in figs. 23 and 24. A circuit diagram of the H.T. types is shown in fig. 21. A circuit diagram of the L.T. types is shown in fig. 22. These two diagrams incorporate the modifications involved in the further "A" versions of the units which are designed, primarily, for use in installations wherein two receivers, type R.1155 are employed. These modifications, which are described in para. 195, involve the fitting of an additional four-point input socket Sk_3 and a relay REL_2 associated with it, in the L.T. unit and a single-pole socket Sk_2 in the H.T. unit. All units are screened to reduce direct radiation interference with radio apparatus.

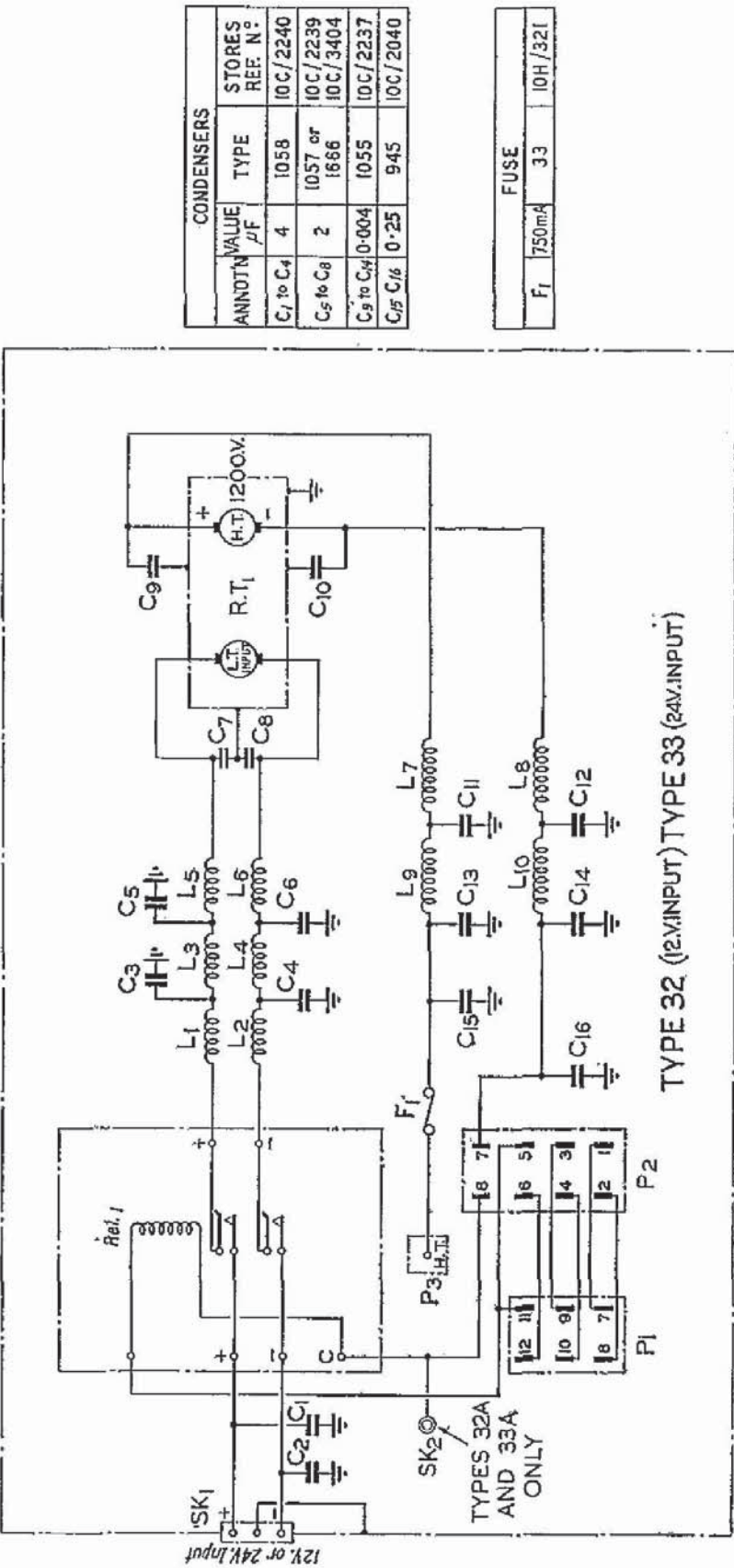
187. When the starter relay contacts of REL_1 are made, the D.C. input to the types 32 or 33 is applied, directly to a symmetrical composite R.F. filter circuit in both positive and negative lines. Each filter circuit is in effect, three series R.F. choke coils $L_1-L_3-L_5$ and $L_2-L_4-L_6$ with condensers between the line and earth. The filtered input appears across two series condensers C_7 and C_8 and the junction of these is connected to the case of the rotary transformer.

188. The rotary transformer is of the open-end type with the H.T. and L.T. armature windings wound on a common armature core, a low resistance shunt field winding being provided. A small series field winding is also incorporated to reduce starting torque. The instrument is designed to give an H.T. voltage as free as possible from commutator ripple which does not exceed 1 per cent. RMS on light load. A cooling fan is mounted on the input end. The L.T. brushes have independent pressure adjustment and both H.T. and L.T. brushes are adjustable for commutating position. The overall efficiency is at a minimum 60 per cent.

189. The output of the machine is taken through a composite filter composed of $L_7, L_9, C_9, C_{11}, C_{13}$ in the positive lead and $L_8, L_{10}, C_{10}, C_{12}, C_{14}$ in the negative lead, each of these condensers having a capacity of $0.004 \mu F$. Two further condensers C_{15} and C_{16} are connected from H.T.+ and H.T.— respectively to earth. The H.T. positive is taken to a single point plug P_3 , and H.T. neg. to pin 7 of the eight-point Jones plug P_2 .

The L.T. power units

190. The units, types 34 and 35, have the D.C. input applied through starter relay REL_1 contacts to a composite filter circuit consisting of three series choke coils and three condensers in each line to the rotary transformer input.



CONDENSERS			STORES REF. N.º
ANNO	VALUE µF	TYPE	
C1 to C4	4	1058	10C/2240
C5 to C8	2	1057 or 1666	10C/2239 10C/3404
C9 to C14	0.004	1055	10C/2237
C15, C16	0.25	945	10C/2040

FUSE		
F1	750mA	33 10H/321

FIG. 21.—CIRCUIT DIAGRAM—H.T. POWER UNIT

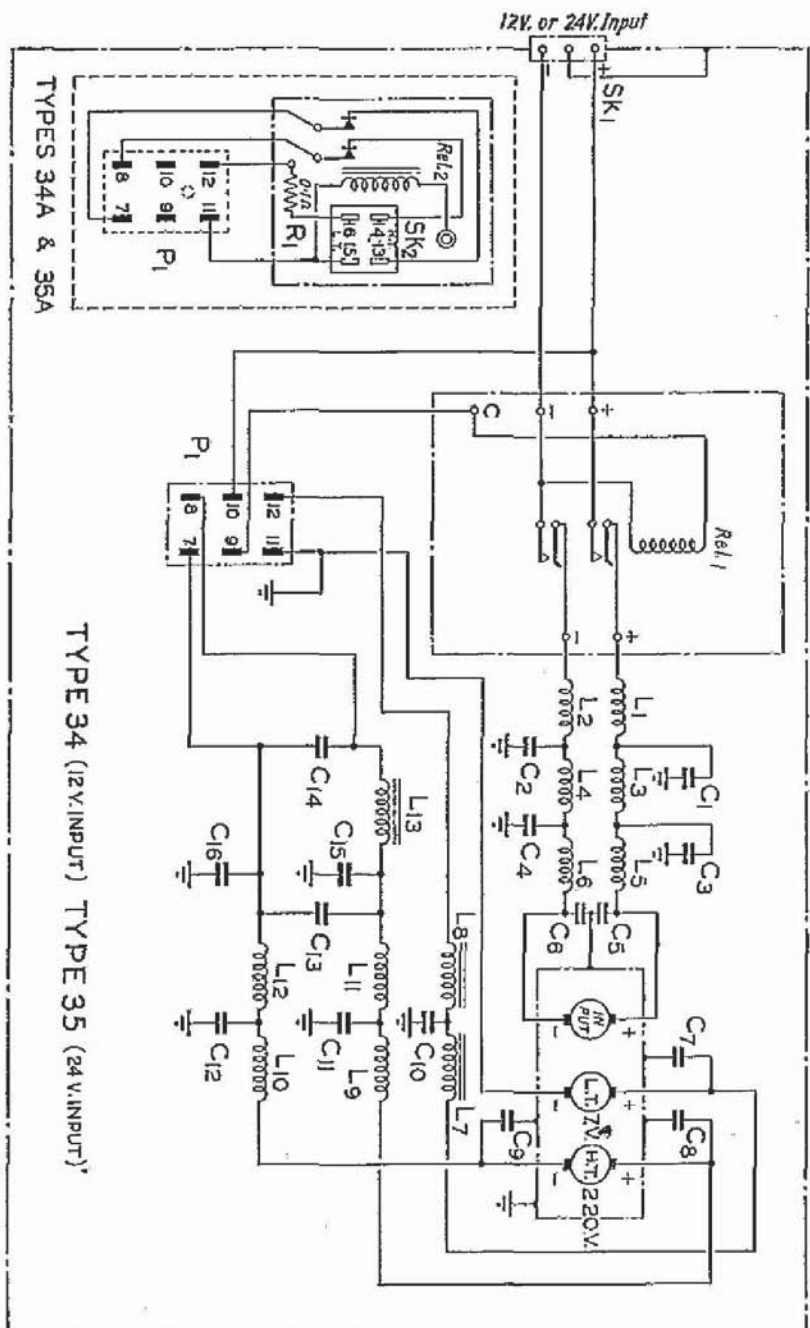


FIG. 22.—CIRCUIT DIAGRAM—L.T. POWER UNIT

CONDENSERS			STORES REF. N°
ANNTN	VALUE μF	TYPE	
C ₁ C ₂	4	1058	10C/2240
C ₁₀			
C ₃ to C ₇	2	1057 or 1666	10C/2239 10C/3404
C ₈ C ₉	0.01	440	10C/10629
C ₁₁ C ₁₂			or 10C/8496
C ₁₃	2	652	10C/288
C ₁₄	4	484	10C/10825
C ₁₅ C ₁₆	0.1	851	10C/800

RESISTANCE		
R ₁	0.1A	2044
		10C/5828

191. The rotary transformer is of the open-end type with H.T. and L.T. armature output windings and the L.T. input winding wound on a common armature core, an L.T. shunt field winding being provided. A small series field winding is also provided to reduce the starting current to a reasonable value. The L.T. negative brush is permanently connected to the frame of the machine. The overall efficiency is, at a minimum, 50 per cent.

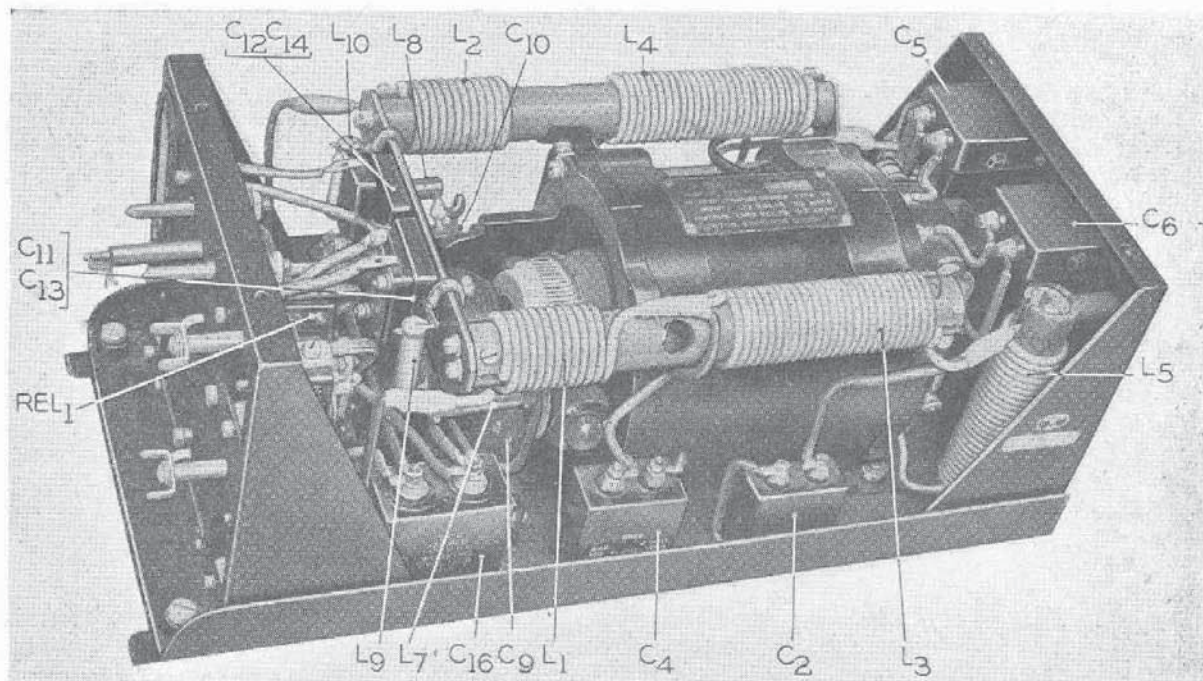


FIG. 23.—POWER UNIT, TYPE 32, INTERIOR VIEW

192. The L.T. output circuit from the transformer is smoothed in the positive line by a filter section comprising two choke coils and condensers C_7 ($2 \mu\text{F}$) and C_{10} ($4 \mu\text{F}$) connected to earth. The negative line is earthed so no filters are necessary. This output appears across the points 12 and 11 of a six-pole plug P_1 . The H.T. output circuit is filtered by the filter C_8 , L_9 , C_{11} , L_{11} and C_9 , L_{10} , C_{12} , L_{12} each condenser of $0.1 \mu\text{F}$ capacitance being connected to earth. The output appears across a $2 \mu\text{F}$ condenser C_{13} and is further filtered to earth by C_{15} and C_{16} (each of $0.1 \mu\text{F}$) and passed to an iron-cored inductance L_{13} and a $4 \mu\text{F}$ condenser C_{14} to appear at the pins 7 (negative) and 8 (positive) of the Jones plug P_1 . The illustration of fig. 24 shows an interior view of the L.T. power units.

193. The development of a separate navigator-operated receiver R.1155 necessitated a further modification to the power units and these variations, which were originally service modified, now constitute the production versions which can substitute for the original types. The modifications have not been mentioned in para. 175 but are incorporated in the diagrams of figs. 21 and 22. The gauze window (1, fig. 1) is cut away for accommodation of the modifications in both cases.

Power units, types 32A, 33A, 34A and 35A

194. The production models of the navigator-operator installations power units are the type 32A (Stores Ref. 10K/13063), type 33A (Stores Ref. 10K/13084), type 34A (Stores Ref. 10K/13065) and type 35A (Stores Ref. 10K/13066). The relay unit REL_2 of the L.T. type is connected in parallel with the starter relay winding of the H.T. power unit. As soon as the latter is started up, the winding of the relay is enlarged and the H.T. supply to the additional receiver, type R.1155 is interrupted by the closing of the relay unit contacts.

195. The following is the sequence of operations when effecting the service modifications which correspond to the types mentioned:—

Modifications to L.T. power units, types 34, 34X and 35

- (i) Remove the top cover of the power unit.

- (ii) Remove the four screws and nuts securing the escutcheon and gauze over the vent hole in the top left-hand corner of the power unit front panel.
- (iii) Remove the nut and screw located near the vent hole which secures one corner of the L.T. starter relay.
- (iv) Mount the plug retaining clamp (Stores Ref. 10K/371) on the front panel of the power unit in accordance with fig. 25 securing it by the screw and nut removed in operation (iii).

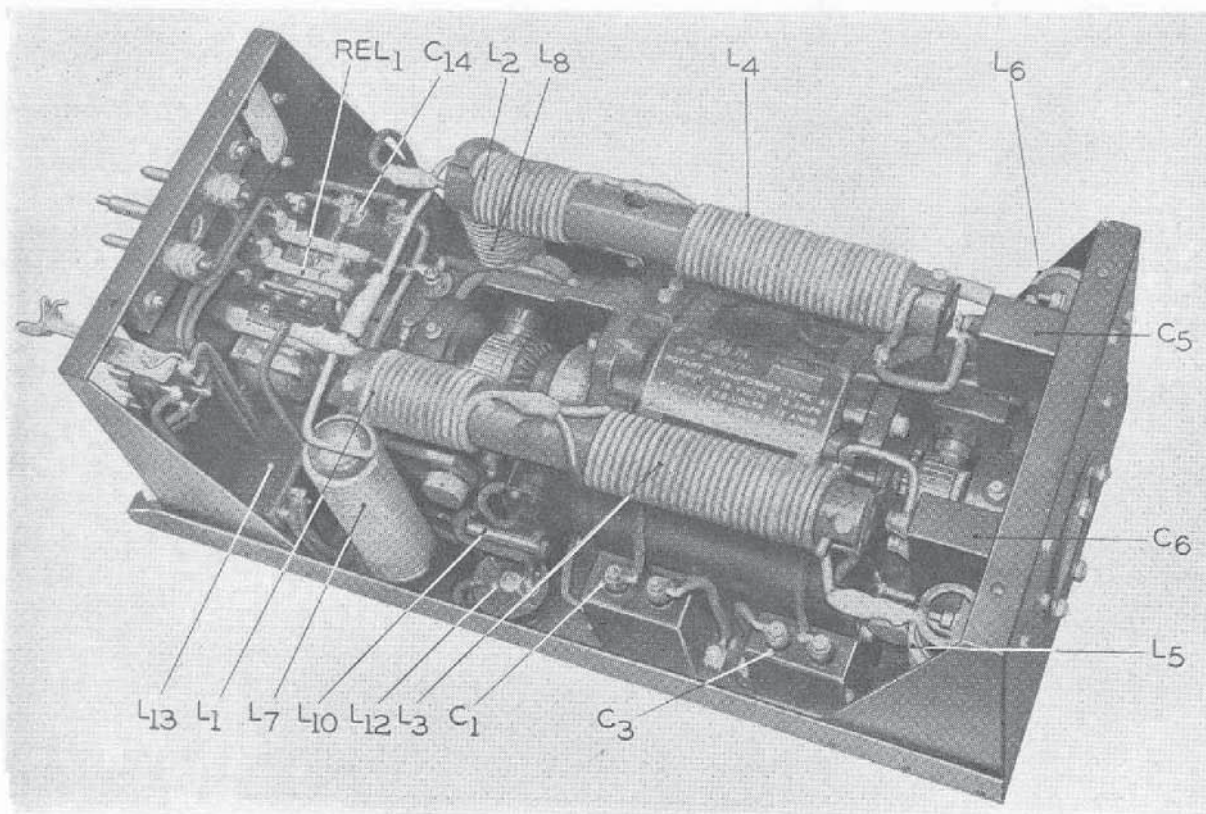


FIG. 24.—POWER UNIT, TYPE 35, INTERIOR VI.

- (v) Mount the relay unit, type 19 (Stores Ref. 10F/723) behind the front panel of the power unit in accordance with the drawing, replacing the escutcheon, but not the gauze, and using two of the screws removed in operation (ii) to secure the unit.
- (vi) Use 16 s.w.g. tinned copper wire (Stores Ref. 5E/1778) encased in insulating tubing (Stores Ref. 5E/1793) connect the relay unit, type 19 to the 6-way plug P_1 type 206 (Stores Ref. 10H/426) on the front panel of the power unit in accordance with the drawing. The plug, type 206 and the socket Sk_2 of the relay unit are assumed to be viewed from behind the front panel of the power unit. These connections are summarized as follows:—
 - (a) Connect spill 12 of the plug, type 206 to the free end of the 0.1-ohm resistance R_1 mounted on the relay unit.
 - (b) Connect spill 11 of the plug, type 206 to spill 15 of the socket Sk_2 on the relay unit.
 - (c) Connect spill 7 of the plug, type 206 to the relay contact A, i.e. the contact making to spill 13 of the socket.
 - (d) Connect spill 8 of the plug, type 206 to the relay contact B, i.e. the contact making to spill 14 of the socket.
- (vii) Replace the top cover of the power unit.

Modifications to H.T. power units, types 32 and 33

- (viii) Remove the top cover of the H.T. power unit.
- (ix) Cut a $\frac{13}{16}$ in. dia. hole in the gauze covering the vent hole and mount the socket, type 314 (Stores Ref. 10H/1802) behind the front panel of the power unit in accordance with the drawing.
- (x) Use 16 s.w.g. tinned copper wire encased in insulating tubing, connect a lead between the socket, type 314, and terminal C of the H.T. starter relay as shown in the drawing.
- (xi) Replace the top cover of the power unit.

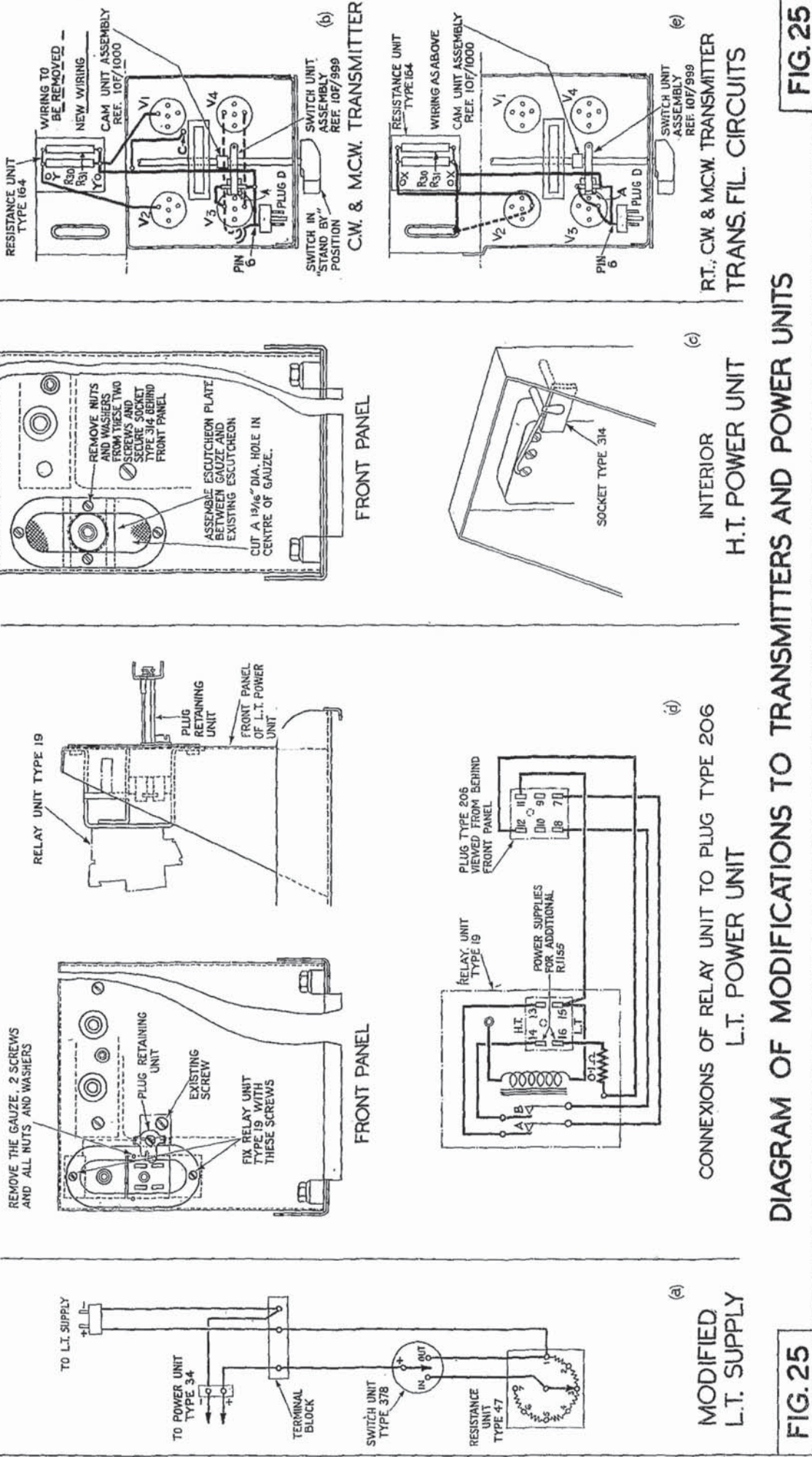


FIG. 25

FIG. 25

Resistance units, types 47 and 52

196. Since the voltage of the aircraft accumulators will alter between charge and no-charge conditions a resistance cut-in arrangement is included in the circuit between the starter accumulator and the L.T. power units, types 34, 34A, 35 or 35A. This compensates for the variation and an adjustment is provided to maintain the filament voltage between 6 and 7.8 volts. The resistance unit is included on the typical installation diagram fig. 18. The resistance is switched in and out of circuit by means of an auxiliary relay, type 219 (Stores Ref. 10F/493) on 12-volt systems or by relay type 220 (Stores Ref. 10F/220) on 24-volt systems. The resistance unit type 47 is designed for 12-volts and the unit type 52 for 24-volts.

197. The relay is energized from the starter battery *via* an extra contact on the charging cut-out. When the cut-out is closed, that is when the accumulator is being charged, the voltage is above normal and the resistance is in circuit to reduce the input voltage of the L.T. power unit to the normal figure obtained when the accumulator is not being charged.

198. When the accumulator is not being charged the auxiliary relay is not energized and the resistance unit is out of circuit. On certain aircraft the resistance unit is placed in circuit manually by means of a switch instead of automatically and precautions should be taken to ensure that the operator clearly understands its manipulation.

199. With the type 47 resistance there is no resistance permanently in circuit and the necessary amount is switched in when the aircraft is in flight. With the type 52 resistance a certain amount of the resistance is always in circuit. To determine the correct value of resistance, tests should be made, firstly on the ground and, secondly in the air, with the aircraft main electrical generator delivering its normal voltage.

Adjusting

200. With the installation completely connected, aircraft accumulators on charge and the whole of the resistance in circuit, that is, connections to resistance on terminals 1 and 6, the following procedure should be adopted:—

- (i) Remove the fan-point socket from right-hand side of the transmitter.
- (ii) Switch on transmitter to TUNE.
- (iii) Measure voltage at terminals of the accumulator supplying current to the L.T. power unit.
- (iv) Measure transmitter L.T. voltage by connecting voltmeter between positive terminal of the morse key and any convenient earthed point on the transmitter as, for example, the pillars holding the plug retaining clip.
- (v) From the TABLES, given below, note the transmitter L.T. voltage as measured at (iii) above.
- (vi) Adjust resistance to the tap shown at the head of the column in which the transmitter L.T. voltage occurs.

201. As an example, suppose the accumulator voltage as measured at (iii) is 14.5 volts and the transmitter L.T. voltage as observed at (iv) is 7.4 volts, then connexion on resistance to terminal 6 should be moved to terminal 5. If, however, the transmitter L.T. voltage was 7.5 volts, or higher, the connexion should be left on terminal 6.

202. The following TABLES L and M are supplied for the purpose of the above adjustment tests.

TABLE L
RESISTANCE UNIT, TYPE 47, 12-VOLT.

Accumulator voltage	TRANSMITTER L.T. VOLTAGE			
	Terminal 6	Terminal 5	Terminal 4	Terminal 3
12.2	6.0	5.9	5.8	5.7
12.5	6.2	6.1	6.0	5.9
12.75	6.35	6.25	6.15	6.05
13.0	6.5	6.4	6.3	6.2
13.25	6.65	6.55	6.45	6.35
13.5	6.8	6.7	6.6	6.5
13.75	7.0	6.9	6.8	6.7
14.0	7.15	7.05	6.95	6.85
14.25	7.35	7.25	7.15	7.05
14.5	7.5	7.4	7.3	7.2
14.7	7.6	7.5	7.4	7.3
15.0	7.8	7.7	7.6	7.5

TABLE M
RESISTANCE, TYPE 52, 24-VOLT

Accumulator voltage	TRANSMITTER L.T. VOLTAGE		
	Terminal 6	Terminal 5	Terminal 4
24.0	5.85	5.75	5.65
24.5	6.02	5.92	5.82
25.0	6.2	6.1	6.0
25.5	6.35	6.25	6.15
26.0	6.5	6.4	6.3
26.5	6.65	6.55	6.45
27.0	6.8	6.7	6.7
27.5	6.95	6.85	6.75
28.0	7.1	7.0	6.9
28.5	7.25	7.15	7.05
29.0	7.4	7.3	7.2
29.5	7.55	7.45	7.35
30.0	7.7	7.6	7.5

203. The standard auxiliary switching relay is the type 219 for 12-volts and type 220 for 24-volts operation. The contacts are arranged so that, on the ground, with the winding non-energized, they are closed and pass the whole of the input current. When, in the air, the winding is energized, the contacts open and the current is applied through the resistance unit.

204. To obviate placing the onus of switching the resistance, in or out of circuit, upon the operator, which would be the case if the relay winding (which consumes the negligible current of approximately 1 amp.) were connected across the main supply and operated by a series wired tumbler switch, the standard electrical cut-out has been modified to include another contact.

205. The contact is marked AUXILIARY or W/T, and when the cut-out closes, this additional contact is connected to the positive supply. Thus, by connecting the winding of the relay, type 219 or 220, between the supply or generator negative and the auxiliary contact the relay is actuated at the same time as the cut-out magnet, that is, the cut-out and the relay are in parallel.

206. If the cut-out, type E or type F is not fitted the switch box type B, 1 unit (Stores Ref. 5C/543) and lead is wired to G+ terminal in the cut-out instead of W/T.

207. The relay, type 219 or type 220 should be mounted where it is not likely to experience much vibration as it is not of very robust construction.

208. The current taken by the L.T. power unit is considerable and the varying lengths of L.T. cable peculiar to varying installations on aircraft may affect the resistance values. It is necessary, therefore, to carry out a type 52 resistance test on each *type* of aircraft.

209. When the transmitter is connected to the self-regulating generator in accordance with A.P.1095/D6, the resistance unit, type 47 or 52, will not be included in the circuit except in those installations which are manually switched. The absence of this resistance is liable to shorten the life of the valves. To reduce risk of failure, instructions for the use of the switch in A.P.1095, Vol. I, Sect. V, Chap. 8, para. 26, should be strictly followed. At the conclusion of any flight in which the emergency connexion has been used, all the transmitter and receiver valves should be replaced.

210. The oilers in the power unit rotary transformers are similar in appearance to greasers but grease should not be used. Instructions have been promulgated in the leaflet A.P.1095/G51—W for removal of the existing oilers and for their replacement by felt plugs which are to be saturated in oil (Stores Ref. 34A/60). The plugs are to be given 5 drops of oil at intervals of, approximately, 30 hours flying.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for these transmitters the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 5	Remarks
10D/97	Transmitter, T.1154	1		R/T, C.W., and M.C.W., ORIGINAL VERSION
	Principal components:—			
10A/12162	Ammeter, thermo, type A Assembly	1	M ₂	0 to 3.5 A.
10D/112	Click lever, compensating	2		
10D/113	Click lever, non-compensating	3		
10D/114	Click ring, A-H	2		
10D/115	Click ring, J-R	2		
10D/116	Click ring, S-Z	1		
	Choke, H.F.			
10C/2054	Type 86	1	HFC ₂	
10C/2087	Type 88	1	HFC ₁	
	Choke, L.F.			
10C/579	Type 46	1	LFC ₂	
10C/581	Type 48	1	LFC ₃	
	Condenser			
10C/8496	Type 188 (or 10C/3103)	2	C ₁₁ , C ₃	0.01 μ F
10C/437	Type 705	1	C ₂₁	0.5 μ F
10C/965	Type 897	2	C ₉ , C ₂₅	0.001 μ F
10C/2018	Type 942	1	C ₁	10 μ F
10C/2038	Type 943	2	C ₅ , C ₆	0.0002 μ F
10C/2039	Type 944	1	C ₇	50 μ F
10C/2040	Type 945	1	C ₈	0.25 μ F
10C/2041	Type 946	1	C ₁₀	0.0002 μ F
10C/2042	Type 947	2	C ₁₂ , C ₂₀	0.004 μ F
10C/2043	Type 948	1	C ₁₄	0.004 μ F
10C/2044	Type 949	2	C ₁₃ , C ₁₉	0.005 μ F
10C/2045	Type 950	3	C ₂₂₋₂₄	0.0003 μ F
10C/2086	Type 976	1	C ₃	6 μ F
10C/3103	Type 1503 (or 10C/8496)	2	C ₁₁ , C ₁₃	0.0085 to 0.05 μ F
10D/117	Drive unit, type 2	1		
	Fitted with:—			
	Assembly			
10D/112	Click lever, compensating	1		
10D/113	Click lever, non-compensating	1		
10D/114	Click ring, A-H	1		
10D/115	Click ring, J-R	1		
10D/116	Click ring, S-Z	1		
	Scale			
10D/205	RANGE 1	1		
10D/206	RANGE 2	1		
10D/207	RANGE 3	1		
10D/208	Disc, marking	3		
	Condenser			
10C/2018	Type 942	1	C ₁	
10C/2044	Type 949	1	C ₁₃	
10C/2086	Type 976	1	C ₃	
	Resistance			
10C/677	Type 868	1	R ₂₅	
10C/1042	Type 1042	2	R ₁ , R ₂	
10H/321	Fuse, type 33	1	F ₁	750 mA
	Holder			
10H/2169	Fuse, type 45	1		
10H/325	Valve, type 50	4		Five-pin
10D/106	Magnifier-unit, type 1	1		With var. cdrs. and coils
10A/12140	Milliammeter, type D	1	M ₁	0 to 300 mA

Ref. No.	Nomenclature	Qty.	Ref. in. fig. 5	Remarks
10D/108	Transmitter T.1154 (<i>contd.</i>) Principal components (<i>contd.</i>) Output-unit, type 2	1		Metal panel, <i>filled with</i> :— 1 off item 10D/106 1 off item 10D/110 2 off item 10D/113 1 off item 10D/114 1 off item 10D/115 2 scale, 0D/204
10H/324	Plug Type 195	1	B	Four-point
10H/430	Type 207	1	C	Single point
10H/437	Type 211	1	E	Four-point
10H/438	Type 212	1	D	Eight-point
10F/151	Relay, magnetic, type 85	1	REL ₁	Keying with 5 m. 5 b. contacts <i>Filled with</i> :— Contact relay Moving, 10F/285 Fixed, 10F/295
10C/677	Resistance Type 868	1	R ₂₆	510 ohms
10C/851	Type 934	1	R ₂₅	51 ohms
10C/877	Type 942	1	R ₂₄	5,100 ohms
10C/1042	Type 1042	2	R ₁ , R ₂	51,000 ohms
10C/1043	Type 1043	1	R ₃	50,000 ohms
10C/1044	Type 1044	1	R ₄	20,000 ohms
10C/1045	Type 1045	2	R ₅ , R ₆	75,000 ohms
10C/1046	Type 1046	1	R ₇ , R ₈	12,000 ohms + 2,000 ohms
10C/1047	Type 1047	1	R ₉	5,000 ohms
10C/1048	Type 1048	1	R ₁₀	350 ohms
10C/1049	Type 1049	1	R ₁₂	15,000 ohms
10C/1050	Type 1050	1	R ₁₄	20,000 ohms
10C/1051	Type 1051	1	R ₁₄	7,500 ohms
10C/1052	Type 1052	1	R ₁₅	820 ohms
10C/1053	Type 1053	1	R ₁₃	680 ohms
10C/1054	Type 1054	1	R ₂₇ , R ₂₈	16 ohms
10C/1055	Type 1055	1	R ₁₉ —R ₂₃	Meter shunt 10 + 2.9 + 5.3 + 12.6 + 69.2 ohms
10C/1056	Type 1056	1	R ₁₀ —R ₁₃	Meter shunt 10 + 19.5 + 19.5 ohms
10C/8208	Type 8208	2	R ₃₀ , R ₃₁	1.5 ohms
10H/442	Socket Type 178	1	A	Eight-point
10H/680	Type 206	1	MIC	Two-point
10F/152	Switch Type 232	1	S ₂	Four-way linked
10F/254	Type 293	1	S ₅	Six-position, three-wafer
10K/12309	Transformer, type 188	1	T ₁	25 : 1
10D/110	Tuning unit, type 10	1		A.T.1 assembly <i>Filled with</i> :— Tapping switches Coils, dust-iron core Tuning device C ₂₇ 1 condenser, type 897 (10C/965) 1 Resistance, type 1055 (10C/1055)
10D/313	Accessories Case, transit	1	S ₆ , S ₇	
10D/330	Screwdriver	1	L ₈	
10E/215	Valve Type V.T.104	2	V ₂ , V ₃	Power amplifiers
10E/216	Type V.T.105	2	V ₁ , V ₄	M/O and modulator
10D/99	Transmitter T.1154A	1	Fig. 3	C.W. and M.C.W. FIRST 1,000 PRODUCTION
10A/12162	Principal components:— Ammeter, thermo, type A	1	M ₃	0 to 3.5 A
10D/518	Case, transmitter	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Transmitter T.1154A (contd.)			
	Principal components (contd.)			
	Choke, H.F.			
10C/578	Type 70	1	HFC ₁	
10C/2054	Type 86	1	HFC ₂	
	Choke, L.F.			
10C/580	Type 47	1	LFC ₁	
10C/582	Type 49	1	LFC ₂	
	Condenser			
10C/8496	Type 188	2	C ₁₁ , C ₁₃	0.01 μ F
	or			
10C/3103	Type 1503	1	C ₂₉	0.0085 μ F to 0.05 μ F
10C/10629	Type 440			
10C/965	Type 897	1	C ₉	0.01 μ F. To be removed
	or			
10C/3381	Type 1647	2	C ₅ , C ₆	0.001 μ F
10C/2038	Type 943			
10C/2039	Type 944	1	C ₇	0.0002 μ F
10C/2041	Type 946	1	C ₁₀	50 μ F
	or			
10C/3279	Type 1593	1	C ₁₃	0.0002 μ F
10C/2042	Type 947	1	C ₁₄	0.004 μ F
10C/2043	Type 948	3	C ₂₂ -C ₂₄	0.004 μ F
10C/2045	Type 950			
	or	1	C ₈	0.0003 μ F
10C/3101	Type 1501			
10C/2053	Type 955	1	C ₈	0.000255 μ F to 0.002 μ F
10C/2055	Type 956	1	C ₂₀	0.25 μ F
	or			
10C/3102	Type 1502	1	C ₂₈	0.004 μ F
10C/3105	Type 1505			
10D/521	Drive unit, type 7	1		0.0034 μ F to 0.05 μ F
	Fitted with:—			
	Assembly			
10D/522	Click lever, compensating	2		
10D/523	Click lever, non-compensating	1		
10D/524	Click ring, A-H	1		
10D/525	Click ring, J-R	1		
10D/526	Click ring, S-Z	1		
	Condenser			
10C/2018	Type 942	1	C ₁	10 μ F
10C/2044	Type 949	2	C ₁₈ , C ₁₉	0.005 μ F
10C/2086	Type 976	1	C ₃	6 μ F
10C/3383	Type 1648	1	C ₂₇	40 μ F
10D/530	Disc marking	3		
10D/570	Plate, operating	3		
	Resistance			
10C/677	Type 868	1	R ₂₆	510 ohms
10C/1042	Type 1042	2	R ₁ , R ₂	50,000 ohms
	or			
10C/6119	Type 6119	1	R ₂₉	24,000 ohms
10C/1931	Type 1931	1		
10F/347	Switch, type 360	1	S ₁	150 ohms
10H/321	Fuse, type 33	5	F ₁	Three-position, four-wafer
	Holder			750 mA
10H/2169	Fuse, type 45	1		
10H/325	Valve, type 50	4		
10A/12140	Milliammeter, type D	1	M ₁	0 to 300 mA
10D/531	Output unit, type 8			
	Fitted with:—			
	Assembly			
10D/523	Click lever, non-compensating	2		
10D/524	Click ring, A-H	1		
10D/525	Click ring, J-R	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Transmitter T.1154A (contd.) Principal components (contd.)			
10D/107	Magnifier unit, type 2	1		Complete with variable condensers and tuning coils
10D/728	Scale, plain	2		
10D/111	Tuning unit, type 11	1		A.T.1 assembly, complete with tapping switches, coils (iron dust core), and tuning device
			C ₂₇	Condenser 10C/965, type 897 or 10C/3381, type 1647 } 1 0.001 μ F
			R ₁₉ , R ₂₀	10C/1055 resistance, type 1055, 1, 100 ohms
	Plug			
10H/324	Type 195	1	B	Four-point
10H/430	Type 207	1	C	Single-point
10H/437	Type 211	1	E	Four-point
10H/438	Type 212	1	D	Eight-point
10F/151	Relay, magnetic, type 85	1	REL ₁	Keying with 6 m. and 6 b. 10F/285, contact, moving 10F/295, contact, fixed
	Resistance			
10C/851	Type 934	1	R ₂₅	51 ohms
10C/877	Type 942	1	R ₂₄	5,100 ohms
10C/1043	Type 1043	1	R ₃	50,000 ohms
10C/1044	Type 1044	1	R ₄	20,000 ohms
10C/1045	Type 1045	2	R ₅ , R ₆	75,000 ohms
10C/1046	Type 1046	1	R ₇ , R ₈	12,000 ohms + 2,000 ohms
10C/1047	Type 1047	1	R ₉	5,000 ohms
10C/1048	Type 1048	1	R ₁₀	350 ohms
10C/1049	Type 1049	1	R ₁₁	15,000 ohms
10C/1050	Type 1050	1	R ₁₂	20,000 ohms
10C/1051	Type 1051	1	R ₁₄	7,500 ohms
10C/1052	Type 1052	1	R ₁₅	820 ohms
10C/1053	Type 1053	1	R ₁₃	680 ohms
10C/1056	Type 1056	1	R ₁₆ -R ₁₈	Meter shunt 49 ohms
10C/8208	Type 8208	2	R ₃₀ , R ₃₁	1.5 ohms
10H/442	Socket, type 178	1	A	Eight-point
	Switch			
10F/152	Type 232	1	S ₂	Three-way
10F/153	Type 233	1	S ₆	Five-position, three-wafer
	Accessories:—			
10D/297	Case, transit	1		
10D/330	Screwdriver	1		
	Valve			
10E/215	Type V.T.104	2	V ₂ , V ₃	Power amplifiers
10E/216	Type V.T.105	2	V ₁ , V ₄	M/O and modulator
10D/196	Transmitter T.1154B			R/T, C.W., M.C.W. REMAINDER PRODUCTION
	Principal components:— As for T.1154A (above) with the following differences:—			
10C/2289	Choke, L.F., type 71	1	LFC ₃	
10C/2220	Condenser, type 1031	1	C ₃₆	2 μ F
	Resistance			
10C/851	Type 934	1	R ₂₅	51 ohms
	or			
10C/1936	Type 1936			
10C/877	Type 942	1	R ₂₄	5,100 ohms
	or			
10C/1872	Type 917			
10C/1047	Type 1047	1	R ₉	4,700 ohms
	or			
10C/6835	Type 6835			

Ref. No.	Nomenclature	Qty.	Ref. in. fig. 5	Remarks
	Transmitter T.1154B (<i>contd.</i>) Principal Components (<i>contd.</i>) Resistance (<i>contd.</i>)			
10C/1044	Type 1049	1	R ₁₁	15,000 ohms
10C/1916	Type 1916			
10C/1050	Type 1050	1	R ₄	20,000 ohms
10C/56	Type 563			
10C/1054	Type 1054	1	R ₂₇ , R ₂₈	16 ohms, tapped at 10 ohms
10C/6833	Type 6833			
10H/442	Socket, type 232	1	MIC	Two-point
10F/348	Switch, type 361	1	S ₅	Six-position, five-wafer
10K/107	Transformer, type 231	1	T ₁	25 : 1
10D/198	Transmitter, T.1154C	1	Fig. 7	R/T, C.W., M.C.W. FOR CERTAIN FLYING BOATS ONLY
	Principal components:—			
	As for T.1154A (above) with the following differences:—			
10D/574	Cask, transmitter	1		
10C/2087	Choke H.F., type 88	1	HFC ₁	
	Choke, L.F.			
10C/579	Type 46	1	LFC ₂	
10C/581	Type 48	1	LFC ₃	
	Condenser			
10C/965	Type 897	1	C ₉	0.001 μ F
10C/2041	Type 946	1	C ₁₀	0.0002 μ F
10C/3101	Type 1501	3	C ₂₂ -C ₂₄	0.000255 to 0.002 μ F
10C/3103	Type 1503	2	C ₁₁ , C ₁₃	0.0085 to 0.02 μ F
10C/3106	Type 1506	2		0.0034 to 0.02 μ F
10D/495	Drive unit, type 6	1		
	Fitted with:—			
	Assembly			
10D/112	Click lever, compensating	2		
10D/113	Click lever, non-compensating	1		
10D/114	Click ring, A-H	1		
10D/115	Click ring, J-R	1		
10D/116	Click ring, S-Z	1		
	Condenser			
10C/3104	Type 1504	2		0.0045 to 0.0115 μ F
10C/3383	Type 1648	1	C ₂₇	40 μ F
10D/208	Disc, marking	3		
	Resistance			
10C/677	Type 868	1	R ₂₆	510 ohms
10C/1042	Type 1042	2	R ₁ , R ₂	51,000 ohms
10C/1931	Type 1931	1	R ₂₉	150 ohms
	Scale, calibrated			
10D/496	RANGE 1 and 2	1		
10D/497	RANGE 3	1		
10D/207	RANGE 4	1		
10F/696	Switch, type 550	1	S ₁	Four-position, four-wafer
10H/321	Fuse, type 33	1	F ₁	750 mA
	Holder			
10H/2169	Fuse, type 45	1		
10H/325	Valve, type 50	4		
10D/498	Output unit, type 7	1		
	Fitted with:—			
	Assembly			
10D/113	Click lever, non-compensating	2		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 7	Remarks
	Transmitter T.1154C (<i>contd.</i>) Principal components (<i>contd.</i>)			
10D/114	Click ring, A-H	1		
10D/115	Click ring, J-R	1		
10D/499	Magnifier unit, type 3	1		<i>Fitted with:—</i> 10C/3415 condenser, type 1676, 2, 0.0006 μ F
10D/204	Scale, plain	2		
10H/1567	Socket, type 307	1		Three-point reversible
	Tuning unit, type 76	1		<i>Fitted with:—</i> 10C/965, condenser, 897, 1 0.001 μ F 10C/1055, resistance, type 1055, 1, 100 ohms
10C/7908	Resistance			
	Type 95	1	R ₄₁	1 megohm
10C/1049	Type 1049			
	or	1	R ₁₁	15,000 ohms
10C/1916	Type 1916			
10C/1050	Type 1050			
	or	1	R ₁₂	20,000 ohms
10C/56	Type 563			
10C/1903	Type 1903	1	R ₄₀	100 ohms
10H/680	Socket, type 206	1	MIC	Two-point
	Switch			
10F/254	Type 293	1	S ₆	Six-position, three-wafer
10F/677	Type 537	1	S ₂	Four-way
10K/12309	Transformer, type 188	1	T ₂	25 : 1
	Accessories:—			
10D/491	Case, transit	1		
10D/730	Transmitter T.1154D Principal components:— This transmitter differs from the standard type in the following components:—	1		
10D/732	Drive unit, type 13	1		
10D/736	Magnifier unit, type 4	1		
10D/738	Output unit, type 10	1		
	Scale			
10D/734	RANGE 1	1		
10D/735	RANGE 2	1		
10D/731	Transmitter, T.1154E Principal components:— This transmitter differs from the standard type in the following components:—	1		
10D/733	Drive unit, type 14	1		
10D/737	Magnifier unit, type 5	1		
10D/739	Output unit, type 11	1		
	Scale			
10D/734	RANGE 1	1		
10D/735	RANGE 2	1		
	INSTALLATION SCHEDULE A schedule of all the items com- prising a complete installation is contained in an APPEN- DIX to the ORDER, A.M.O.N/1243/1941 The subjoined schedule of con- nector sets embodies details available at the time of com- pilation.			

Ref. No.	Nomenclature	Qty.	Ref. in, fig. 19	Remarks
	CONNECTORS		Fig. 19	For KEY refer to diagram
10H/1556	Connector set, type T.1154/ R.1155/A	1		SUNDERLAND AIRCRAFT, Mk. II and III, fitted with single receiver
	Comprising:—			
10H/1634	Connector Type 541/1	1	14	Sextocorem, 1 ft. 3 in. long <i>Fitted with:—</i>
10H/1635	Type 542/1	1	16	10H/427, Socket, type 168, 2 Octocorem No. 2, 3 ft. 2 in. long. <i>Fitted with:—</i>
10H/1636	Type 543/1	1	15	10H/434, plug, type 210, 1 10H/322, socket, type 137, 1 Octocorem No. 1, 3 ft. long <i>Fitted with:—</i>
10H/1637	Type 544/1	1	18	10H/322, socket, type 137, 1 10H/424, socket, type 174, 1 Uniplugmet No. 1, 3 ft. 6 in. long. <i>Fitted with:—</i>
10H/1638	Type 545/1	1	13	10H/429, socket, type 170, 1 10H/435, socket, type 176, 1 Quadramet 4, 1 ft. 10 in. long <i>Fitted with:—</i>
10H/1639	Type 546/1	1	17	10H/425, socket, type 175, 2 Dulocapmet, No. 1, 13 ft. 8 in. long. <i>Fitted with:—</i>
10H/1718	Type 548/1	1		10H/433, plug, type 209, 1 10H/11051, socket, type 63, 1 Ducel 4, 6 in. long <i>Fitted with:—</i>
	The following items to be pro- visioned for fourteen connectors without reference numbers:—			10H/425, socket, type 175, 1
10H/451	Plug, type 217	1		
	Socket			
10H/8531	Type 40	1		
10H/319	Type 135	2		
10H/320	Type 136	4		
10H/322	Type 137	1		
10H/428	Type 169	1		
10H/431	Type 171	2		
10H/422	Type 172	4		
10H/423	Type 173	2		
	Cable			
5E/82	Unispark 7	19 ft.		
5E/86	Uniflex 19	6 ft.		
5E/916	Unisheath 4	7 ft.		
5E/1328	Dumet 4	9 ft.		
5E/1349	Ducel 19	4 ft.		
5E/1351	Trimet 4	36 ft.		
5E/1362	Ducel 4	10 ft.		
10H/1735	Connector set, type T.1154/2-R.1155/A	1		SUNDERLAND, Mk. II and III. Fitted with navigator operated R.1155
	Connectors, as items 10H/1634- 10H/1636 inclusive			
10H/1637	Type 544/1			As above, but 4 ft. long
10H/2317	Type 545/3	1		Dulocapmet No. 1, 6 ft. 6 in. long. <i>Fitted with:—</i>
10H/1639	Type 546/1			10H/433, plug, type 209, 1 10H/11051, socket, type 63, 1 Omitted

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
10H/1640	CONNECTORS (<i>contd.</i>) Connector set, type T.1154/2-R.1154/A (<i>contd.</i>) Comprising (<i>contd.</i>) Type 547/1	1		Dumet 7, 25 ft. long Dumet 4, 25 ft. long Ducel 4, 9 ft. 6 in. long Fitted with:— 10H/1518, plug, type 358, 1 10H/1498, socket, type 299, 1
10H/8531	Plug, type 68	2		
5E/1351	Cable	28 ft.		
5E/130	Trimet 4	3 ft.		
10H/1276	Unisheath 7 Switch, type 9	1		S-P, two-way
	The following items are required to convert single receiver installation to two receiver installation			SUNDERLAND
10H/1986	Connector set, type T.1154/R.1155/Convn./A			
10H/2317	Comprising:— Connector Type 543/3	1		Dulocapmet, 6 ft. 6 in. long Fitted with:— 10H/433, plug, type 209, 1 10H/11051, socket, type 63, 1 Replaces 10H/1639 when converting to two receiver installation As item 10H/1640
10H/1640	Type 547/1	1		
	The following items to be provisioned for two connectors without reference numbers:—			
5E/1351	Cable, Trimet 4	18 ft.		
10H/322	Socket, type 137	1		
5E/130	Cable, Unisheath	3 ft.		
10H/8531	Socket, type 68	2		
10H/1276	Switch, type 9	1		
10H/1546	Connector set, type T.1154/R.1155/AE	1		Replaces receiver to visual indicator connector Connector between Power Units S-P, two-way
	Comprising:— Connector			HALIFAX I. Fitted with single receiver
10H/1951	Type 541/2	1		See item 10H/1634
10H/1653	Type 542/3	1		As item 10H/1635, but 2 ft. 4 in. long
10H/1654	Type 543/4	1		As item 10H/1636 but 1 ft. 6 in. long
10H/1655	Type 544/3	1		As item 10H/1637, but 1 ft. 6 in. long
10H/1656	Type 545/4	1		As item 10H/1638, but 6 ft. 8 in. long
10H/1657	Type 546/4	1		As item 10H/1639, but 18 ft. 6 in. long
10H/1718	Type 548/1	1		As item 10H/1718

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (contd.)			
	The following items to be provisioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423 inclusive:—			
	Cable			
5E/82	Unispark 7	21 ft.		
5E/86	Uniflex 19	6 ft.		
5E/916	Unisheath 4	6 ft.		
5E/1328	Dumet 4	4 ft.		
5E/1340	Ducel 19	5 ft.		
5E/1351	Trimet 4	14 ft.		
5E/1362	Ducel 4	4 ft.		
10H/1985	Connector set, type T.1154/2-R.1155/AE Items required to convert single receiver installation to two receiver installation	1		HALIFAX I. Fitted with navigator-operated receiver
10H/13025	Connector set, type T.1154/R.1155/Convul./AE	1		
10H/1023	Connector set, type T.1154/R.1155/ADZ	1		HAMPDEN. Fitted with single receiver
	Comprising:— Connector			
10H/1646	Type 541/3	1		As item 10H/1634, but 1 ft. 6 in. long
10H/1647	Type 542/2	1		As item 10H/1635, but 4 ft. 0 in. long
10H/1648	Type 543/3	1		As item 10H/1636, but 4 ft. 8 in. long
10H/1649	Type 544/2	1		As item 10H/1637, but 4 ft. 8 in. long
10H/1650	Type 545/3	1		As item 10H/1638, but 1 ft. 8 in. long
10H/1718	Type 548/1	1		As 10H/1718 SUNDERLAND
	The following items to be provisioned for sixteen connectors without reference numbers:— As items 10H/451 to 10H/423 inclusive, with:—			
	Cable			
5E/82	Unispark 7	40 ft.		
5E/86	Uniflex 19	5 ft.		
5E/916	Unisheath 4	7 ft.		
5E/1328	Dumet 4	7 ft.		
5E/1351	Trimet 4	24 ft.		
5E/1362	Ducel 4	8 ft.		
5E/1365	Ducel 37	16 ft.		
5E/2033	Dulocapmet No. 1	10 ft.		
10H/1983	Connector set, type T.1154/2-R.1155/AD Items required to convert a single receiver installation to two receiver installation:—	1		HAMPDEN. Fitted with navigator-operated receiver
10H/13022	Connector set, type T.1154/R.1155/Convul./AD	2		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (<i>contd.</i>)			
10H/1547	Connector set, type T.1154/R.1155/AF Comprising:— Connector	1		MANCHESTER. Fitted with single receiver
10H/1659	Type 541/4	1		As item 10H/1634, but 1 ft. 2 in. long
10H/1660	Type 542/4	1		As item 10H/1635, but 3 ft. 0 in. long
10H/1661	Type 543/5	1		As item 10H/1636, but 6 ft. 2 in. long
10H/1662	Type 544/4	1		As item 10H/1637, but 6 ft. 3 in. long
10H/1663	Type 545/5	1		As item 10H/1638, but 4 ft. 6 in. long
10H/1664	Type 546/5	1		As item 10H/1639, but 4 ft. 2 in. long
10H/1718	Type 548/1	1		As item 10H/1718, SUNDERLAND
	The following items to be pro- visioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423, inclusive, with:— Cable			
5E/82	Unispark 7	17 ft.		
5E/86	Uniflex 19	7 ft.		
5E/916	Unisheath 4	10 ft.		
5E/1328	Dumet 4	3 ft.		
5E/1351	Trimet 4	22 ft.		
5E/1362	Ducel 4	3 ft.		
5E/1364	Ducel 19	3 ft.		
10H/1988	Connector set, type T.1154/2-R.1155/AF Items required to convert single receiver installation to two re- ceiver installation:—	1		MANCHESTER. Fitted with navigator-operated receiver
10H/13026	Connector set, type T.1154/R.1155/Convsn./AF/AU	1		
10H/1548	Connector set, type T.1154C/R.1155/AG Comprising:— Connector	1		STIRLING Fitted with single receiver As these connectors differ only in length from items pre- viously given these differ- ences, only, will be shown here
10H/1666	Type 541/5	1		7½ in.
10H/1667	Type 542/5	1		As item 10H/1635
10H/1668	Type 543/6	1		5 ft. 6 in.
10H/1669	Type 544/5	1		4 ft. 8 in.
10H/1670	Type 545/6	1		5 ft. 1 in.
10H/1671	Type 546/6	1		13 ft. 0 in.
10H/1718	Type 548/1	1		
	The following items to be pro- visioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423 inclusive, with:— Cable			
5E/82	Unispark 7	23 ft.		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (contd.)			
	Connector set, type			
	T.1154C/R.1155/AG (contd.)			
	Comprising, (contd.)			
	Cable (contd.)			
5E/86	Uniflex 19	10 ft.		
5E/916	Unisheath 4	14 ft.		
5E/1328	Dumet 4	3 ft.		
5E/1351	Trimet 4	47 ft.		
5E/1362	Ducel 4	3 ft.		
5E/1364	Ducel 19	17 ft.		
10H/1991	Connector set, type T.1154/2R.1155/AG Items required to convert a single receiver installation to two re- ceiver installations:—	1		STIRLING. Fitted with navi- gator operated receiver
10H/1307	Connector set, type T.1154/R.1155/Convsn./AG	1 1		
10H/1544	Connector set, type T.1154/R.1155/H Comprising:—	1		WELLINGTON IC, II, III, IV Fitted with single receiver
	Connector			
10H/1719	Type 541/6	1		5 ft. 5 in.
10H/1635	Type 542/1	1		
10H/1721	Type 543/7	1		3 ft. 5 in.
10H/1722	Type 544/6	1		3 ft. 8 in.
10H/1723	Type 545/7	1		3 ft. 9 in.
10H/1724	Type 546/7	1		10 ft. 3 in.
10H/1718	Type 548/1	1		
	The following items to be pro- visioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423 inclusive, with:—			
	Cable			
5E/82	Unispark 7	15 ft.		
5E/86	Uniflex 19	8 ft.		
5E/916	Unisheath 4	8 ft.		
5E/1328	Dumet 4	6 ft.		
5E/1351	Trimet 4	16 ft.		
5E/1362	Ducel 4	6 ft.		
5E/1364	Ducel 19	7 ft.		
10H/1982	Connector set, type T.1154/2-R.1155/H Items required to convert a single receiver installation to a two receiver installation	1		WELLINGTON IC, II, III, IV. Fitted with navigator- operated receiver
10H/13023	Connector set, type T.1154/R.1155/Convsn./H	1		
10H/1545	Connector set, type T.1154/R.1155/G Comprising:—	1		WHITLEY V. Fitted with single receiver
	Connector			
10H/1686	Type 541/7	1		12 in.
10H/1635	Type 542/1	1		
10H/1687	Type 543/9	1		1 ft. 1 in.
10H/1688	Type 544/8	1		12 in.
10H/1689	Type 545/9	1		3 ft. 5 in.
10H/1690	Type 546/9	1		6 ft. 8 in.
10H/1718	Type 548/1	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (contd.) Connector set, type T.1154/R.1155/G (contd.) Comprising (contd.) The following items to be provisioned for fourteen connectors without reference numbers:— As items 10H/451 to 10H/423 inclusive, with:— 5E/82, 12 ft.; 5E/86, 5 ft.; 5E/916, 9 ft.; 5E/1328, 5 ft.; 5E/1351, 25 ft.; 5E/1362, 6 ft.; 5E/1365, 8 ft.			
10H/1984	Connector set, type T.1154/2R.1155/G Items required to convert a single receiver installation to a two receiver installation:—	1		WHITLEY V. Fitted with navigator operated receiver
10H/13024	Connector set, type T.1154/R.1155/Convsn./G	1		
10H/1550	Connector set type T.1154/R.1155/P Comprising:— Connector	1		BEAUFIGHTER. Fitted with single receiver
10H/1693	Type 541/8	1		11 in.
10H/1694	Type 542/8	1		4 ft. 7 in.
10H/1695	Type 543/10	1		4 ft. 8 in.
10H/1696	Type 544/9	1		5 ft. 1 in.
10H/1697	Type 545/10	1		1 ft. 3 in.
10H/1698	Type 546/10	1		15 ft. 0 in.
10H/1718	Type 548/1 The following items to be provisioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423, inclusive, with:— 5E/82, 38 ft.; 5E/86, 9 ft.; 5E/916, 8 ft.; 5E/1328, 5 ft.; 5E/1351, 30 ft.; 5E/1362, 5 ft.; 5E/1364, 6 ft.	1		
10H/972	Connector set, type T.1154/R.1155/T Comprising:— Connector	1		BLLENHEIM IV. Fitted with single receiver
10H/1700	Type 541/9	1		2 ft. 4 in.
10H/1701	Type 542/9	1		3 ft. 6 in.
10H/1702	Type 543/11	1		8 ft. 6 in.
10H/1703	Type 544/10	1		8 ft. 6 in.
10H/1704	Type 548/11	1		3 ft. 0 in.
10H/1718	Type 548/1 The following items to be provisioned for fifteen connectors without reference numbers:— As items 10H/451 to 10H/423, inclusive, with:— 5E/82, 21 ft.; 5E/86, 8 ft.; 5E/916, 9 ft.; 5E/1328, 7 ft.; 5E/1362, 8 ft.; 5E/1365, 11 ft.	1		
10H/1987	Connector set, type T.1154/2R.1155/T The following items are required to convert single receiver installation to two receiver installation:—	1		BLLENHEIM IV. Fitted with navigator operated receiver
10H/13021	Connector set, type T.1154/R.1155/Convsn./T			

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
10H/1554	CONNECTORS (contd.) Connector set, type T.1154/R.1155/AB Comprising:— Connector	1		WELLINGTON V. Fitted with single receiver
10H/1641	Type 541/10	1		2 ft. 0 in.
10H/1720	Type 542/7	1		4 ft. 6 in.
10H/1642	Type 543/2	1		3 ft. 6 in.
10H/1723	Type 544/7	1		3 ft. 4 in.
10H/1643	Type 545/2	1		6 ft. 0 in.
10H/1644	Type 546/2	1		3 ft. 2 in.
10H/1718	Type 548/1 The following items to be pro- visioned for fifteen connectors without reference numbers:— As items 10H/451, 10H/319 to 10H/423, inclusive, with:— 5E/82, 26 ft.; 5E/86, 16 ft.; 5E/916, 11 ft.; 5E/1328, 6 ft.; 5E/1364, 10 ft.; 5E/1351, 17 ft.; 5E/1362, 6 ft.	1		
10H/13115	Connector set, type T.1154/2R.1155/AB The following items are required to convert single receiver installation to two receiver installation:—	1		WELLINGTON V. Fitted with navigator operated receiver
10H/13029	Connector set, type T.1154/R.1155/Convsn./AB	1		
10H/1555	Connector set, type T.1154/2-R.1155/AM Comprising:— Connector	1		BLenheim V. Fitted with navigator operated receiver
10H/1711	Type 541/11	1		3 ft. 7 in.
10H/1712	Type 542/10	1		3 ft. 6 in.
10H/1713	Type 543/12	1		2 ft. 6 in.
10H/1714	Type 544/12	1		2 ft. 8 in.
10H/1716	Type 546/13	1		13 ft. 0 in.
10H/1717	Type 547/14	1		Dumet 7, 30 ft. 0 in. Dumet 4, 30 ft. 0 in.
10H/1718	Type 548/1 The following items to be pro- visioned for sixteen connectors without reference numbers:— As items 10H/451 to 10H/423, inclusive, with:—	1		Ducel 4, 8 ft. 0 in.
10H/6516	Plug, type 68 Items 5E/82, 14 ft.; 5E/86, 6 ft.; 5E/130, 5 ft.; 5E/196, 10 ft.; 5E/1328, 4 ft.; 5E/1351, 15 ft.; 5E/1362, 13 ft.; 5E/ 1364, 7 ft.	2		
10H/1551	Connector set, type T.1154/R.1155/AH Comprising:— Connector	1		ALBEMARLE. Fitted with single receiver
10H/1726	Type 541/12	1		2 ft. 10 in.
10H/1673	Type 542/11	1		4 ft. 7 in.
10H/1674	Type 543/8	1		15 ft. 6 in.
10H/1675	Type 544/11	1		15 ft. 6 in.
10H/1676	Type 545/8	1		8 in.
10H/1677	Type 546/8	1		2 ft. 6 in.
10H/1718	Type 548/1	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (<i>contd.</i>) Connector set, type T.1154/R.1155/AH (<i>contd.</i>) Comprising (<i>contd.</i>) Connector (<i>contd.</i>) The following items to be provisioned for fourteen connectors without reference numbers:— As items 10H/451 to 10H/453, inclusive, with:— Items 5E/82, 15 ft.; 5E/86, 10 ft.; 5E/916, 7 ft.; 5E/1328, 3 ft.; 5E/1351, 14 ft.; 5E/1362, 3 ft.; 5E/1364, 6 ft.			
10H/1990	Connector set, type T.1154/2R.1155/AH Items required to convert single receiver installation to two receiver installation:—	1		ALBEMARLE. Fitted with navigator operated receiver
10H/13028	Connector set, type T.1154/R.1155/Convsn./AH			
10H/1549	Connector set, type T.1154/R.1155/C Comprising:— Connector	1		BEAUFORT. Fitted with single receiver
10H/1679	Type 541/15	1		4 ft. 4 in.
10H/1680	Type 542/15	1		4 ft. 3 in.
10H/1681	Type 543/15	1		2 ft. 8 in.
10H/1682	Type 544/15	1		3 ft. 1 in.
10H/1697	Type 545/10	1		1 ft. 3 in.
10H/1718	Type 548/1	1		
	The following items to be provisioned for fifteen connectors without reference numbers:— Plug, type 209 Items 10H/451 to 10H/423, inclusive, with:— Items 5E/82, 14 ft.; 5E/86, 7 ft.; 5E/916, 12 ft.; 5E/1328, 5 ft.; 5E/1351, 22 ft.; 5E/1362, 5 ft.; 5E/1364, 7 ft.			
10H/433				
10H/1552	Connector set, type T.1154/R.1155/U Comprising:— Connector	1		MOSQUITO. Fitted with single receiver
10H/1707	Type 541/14	1		3 ft. 2 in.
10H/1732	Type 542/14	1		3 ft. 9 in.
10H/1733	Type 543/14	1		5 ft. 6 in.
10H/1708	Type 544/14	1		5 ft. 8 in.
10H/1734	Type 545/14	1		1 ft. 10 in.
10H/1718	Type 548/1	1		
	The following items to be provisioned for fifteen connectors without reference numbers:— As items 5E/82, 16 ft.; 5E/86, 6 ft.; 5E/916, 7 ft.; 5E/1328, 13 ft.; 5E/1351, 10 ft.; 5E/1362, 8 ft.; 5E/1364, 8 ft.			
10H/1738	Connector set, type T.1154/R.1155/D Comprising:— Connector	1		BOTHA. Fitted with single receiver
10H/1727	Type 541/13	1		9½ in.
10H/1728	Type 542/12	1		2 ft. 6 in.
10H/1654	Type 543/4	1		1 ft. 6 in.
10H/1729	Type 544/13	1		1 ft. 3¼ in.
10H/1730	Type 545/13	1		11½ in.
10H/1731	Type 546/12	1		1 ft. 9 in.
10H/1718	Type 548/1	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 19	Remarks
	CONNECTORS (<i>contd.</i>)			
	Connector set, type T.1154/R.1155/D (<i>contd.</i>)			
	Comprising (<i>contd.</i>)			
	Connector (<i>contd.</i>)			
	The following items to be provisioned for fourteen connectors without reference numbers:—			
	Items 10H/451 to 10H/423, inclusive, with:—			
	Items 5E/86, 5 ft.; 5E/916, 4 ft.; 5E/1328, 7 ft.; 5E/1364, 11 ft.; 5E/1351, 23 ft.; 5E/1362, 6 ft.			
10H/1553	Connector set, type T.1154/R.1155/AJ	1		ANSON. Fitted with single receiver
	Comprising:—			
	Connector			
10H/1651	Type 541/16	1		8½ in.
10H/1683	Type 542/13	1		3 ft. 1½ in.
10H/1684	Type 543/13	1		3 ft. 8½ in.
10H/1709	Type 544/16	1		3 ft. 11 in.
10H/1705	Type 545/12	1		3½ in.
10H/1718	Type 548/1			
	The following items to be provisioned for seventeen connectors without reference numbers:—			
10H/8118	Plug, type 62	1		
10H/7961	Disc, indicating, type P/62/D	1		
10H/9872	Plug, type 101	1		
	With items 10H/433 to 10H/423, inclusive, and items:—			
	5E/82, 13 ft.; 5E/86, 10 ft.; 5E/916, 10 ft.; 5E/1328, 4 ft.; 5E/1351, 18 ft.; 5E/1362, 5 ft.; 5E/1365, 2 ft.; 5E/2057, 5 ft.			
10H/1992	Connector set, type T.1154/2 R.1155/AV	1		WARWICK. Fitted with navigator operated receiver
10H/1993	Connector set, type T.1154/2 R.1155/AU	1		LANCASTER. Fitted with navigator operated receiver
10K/17	Power unit, type 32			12-volts
	Principal components:—			
10K/71	Base	1		
10K/72	Cover	1		
	Choke, H.F.			
10C/2232	Type 95	2		
10C/2233	Type 96	2		
10C/2234	Type 97	4		
	Condenser			
10C/2040	Type 945	2	C ₁₅ , C ₁₆	0.25 μF
	or			
10C/2238	Type 1056	6	C ₉ –C ₁₄	0.004 μF
10C/2239	Type 1057			
	or	4	C ₆ –C ₈	2 μF
10C/3404	Type 1666			
10C/2240	Type 1058	4	C ₁ –C ₄	4 μF
10H/623	Clip, type 13	3		
10H/321	Fuse, type 33	1		750 mA
10H/2169	Holder, fuse, type 45	1		
10K/21	Rotary transformer, type 28	1	RT ₁	In: 12 v., 240 w. Out: 1,200 v., 200 mA
	Plug,			
10H/426	Type 206	1	P ₁	
10H/430	Type 207	1		
10H/438	Type 212	1	P ₂	
10H/624	Type 245	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 21	Remarks
	CONNECTORS (<i>contd.</i>)			
	Connector set, type T.1154/2 R.1155/AU (<i>contd.</i>)			
10F/331	Comprising (<i>contd.</i>)			
10K/13063	Starter, type 5	1	REL ₁	12 volts
	Power unit, type 32A			
	Principal components:—			
10H/1802	As for type 32 (above) with:—	1		Fitted with:— 10H/9352 socket, type 47
10K/18	Socket unit, type 314			24 volts
	Power unit, type 33			
	Principal components:—			
	As for type 32 (above) except:			
10C/2736	Choke, H.F.	2		Substitute for 10C/2232
10C/2737	Type 121	2		Substitute for 10C/2233
10K/13064	Type 122			24 volts
	Power unit, type 33A			
	Principal components:—			
10H/1802	As for type 33 with:—			See power unit, type 32A
10K/19	Socket unit, type 314			12 volts
	Power unit, type 34			
	Principal components:—			
10K/73	Base	1		
10K/72	Cover	1		
	Choke, H.F.			
10C/2232	Type 95	2		
10C/2233	Type 96	2		
10C/2234	Type 97	2		
10C/2235	Type 98—spools	2		
10C/2236	Type 99	2		
10C/3146	Choke, L.F., type 110	1		
	Condenser			
10C/10629	Type 440	4	C ₃ , C ₉ , C ₁₁ , C ₁₂	0.01 μ F. May be marked 10C/8496
10C/10825	Type 484	1	C ₁₄	4 μ F
10C/288	Type 652	1	C ₁₃	2 μ F
10C/800	Type 851	2	C ₁₅ , C ₁₆	0.1 μ F
10C/2239	Type 1057	5	C ₃ —C ₇	2 μ F
	or			
10C/3404	Type 1666	3	C ₁ , C ₂ , C ₁₀	4 μ F
10C/2240	Type 1058			
10H/623	Clips, type 13	1		
	Plug			
10H/426	Type 206	1	P ₁	6-point
10H/624	Type 245	1		
10K/23	Rotary transformer	1	RT ₁	In: 12 v., 100 w. Out: 240 v., 100 mA H.T. 5.8 v., 13 A., L.T.
10F/332	Starter, type 6	1	REL ₁	12 volts
10K/13065	Power unit, type 34A			
	Principal components:—			
	As power unit, type 34, with:—			
10K/371	Plug retaining unit, type 19	1		
10F/723	Relay unit, type 19	1	REL ₂	
10C/8528	Resistance, type 2044	1	R ₁	0.1 ohm
10H/327	Socket, type 138	1		4-point
10K/20	Power unit, type 35			24 volts
	Principal components:—			
	As for power unit, type 34, except:—			
10F/334	Starter, type 8	1	REL ₁	Substitute for 10F/332
10K/13066	Power unit, type 35A			24 volts
	Principal components:—			
	As for power unit, type 35, with items:—			
	10K/371, 10F/723, 10C/8528 and 10H/327 (See power unit, type 34A)			

APPENDIX 2

TRANSMITTERS, Type T.1154F, G, H, J, K, L, M, N, and P

1. The above transmitters are all variants of the basic T.1154 series. They are, for the most part, electrically similar to the type from which they have been developed. Physically there are differences, brought about, in some versions, by the use of the new type click-stop mechanism referred to in para. 121 of this chapter. This type is now known as the "Uni" click-stop as opposed to the older version, the "Multi" click-stop. A general view of the transmitter with new click-stop mechanism is shown in fig. 26. Details of the new mechanism are given in paras. 3 to 10 of this Appendix.

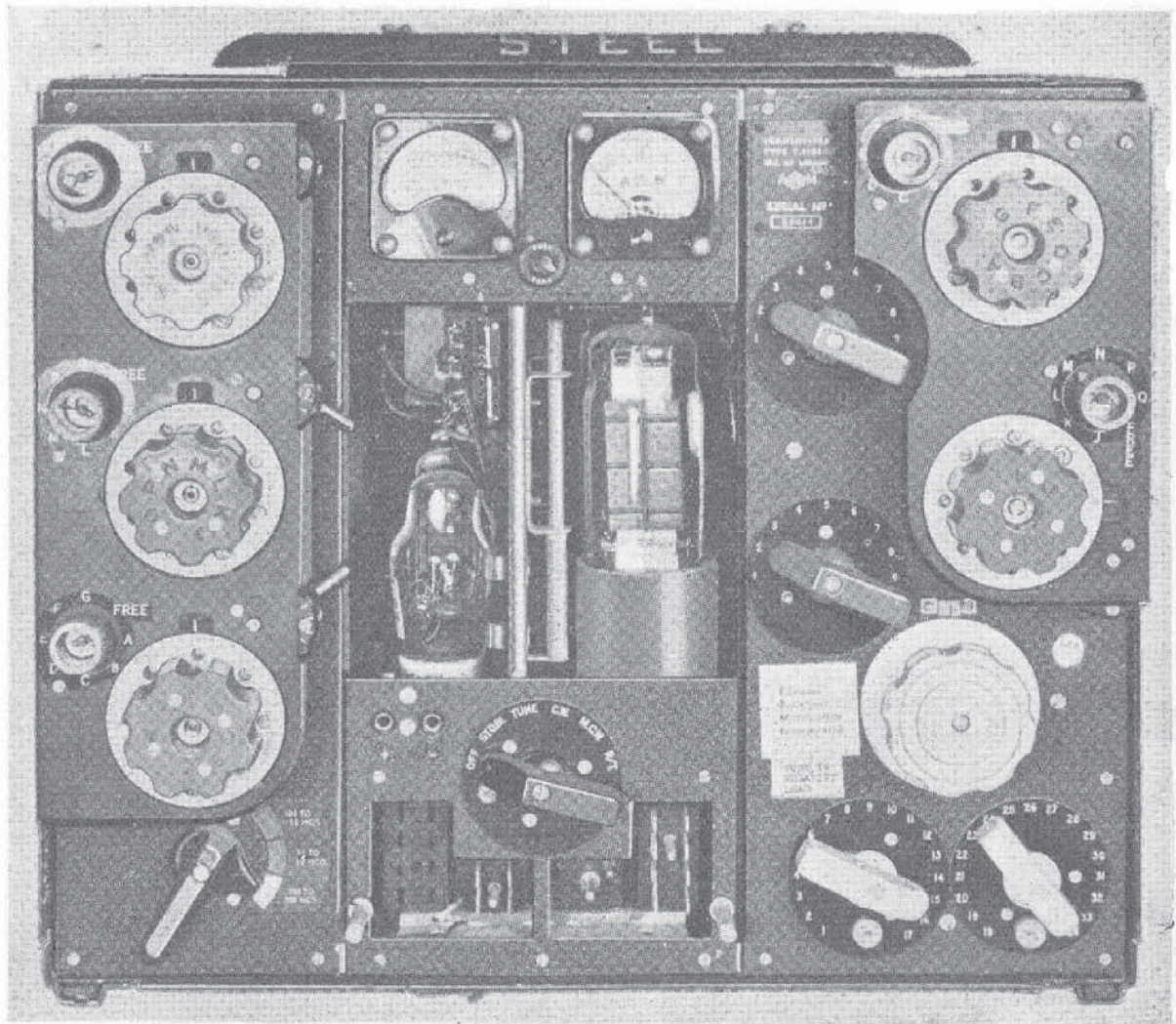


Fig. 26.—Typical transmitter fitted with "Uni" click-stop mechanism.

2. The following list of transmitters, stores reference numbers and basic types from which developed, is supplied for reference:—

<i>Transmitter type</i>	<i>Stores Ref. No.</i>	<i>Basic type</i>	<i>Comments</i>
T.1154F	10D/893	T.1154C	"Multi" click-stop mechanism. Aluminium case.
T.1154G	10D/1179	T.1154B	"Uni" click-stop mechanism. Aluminium case.
T.1154H	10D/1180	T.1154C	"Uni" click-stop mechanism. Aluminium case.
T.1154J	10D/1329	T.1154B	"Multi" click-stop mechanism. Steel case.
T.1154K	10D/1330	T.1154C	"Multi" click-stop mechanism. Steel case.
T.1154L	10D/1455	T.1154L	Range 5.5–10.0 Mc/s is replaced by range 1.5–3.0 Mc/s. Designed for A.S.R. launches. "Uni" click-stop mechanism. Steel case.
T.1154M	10D/1587	T.1154C	"Uni" click-stop mechanism. Steel case.
T.1154N	10D/1588	T.1154B	"Uni" click-stop mechanism. Steel case.
T.1154P	10D/1668	T.1154L	"Multi" click-stop mechanism. Aluminium case. Unlikely to be brought into Service use—only experimental model produced.

The "Uni" click-stop mechanism

3. This mechanism is fitted to the control knobs of all tuning condensers. It enables each control to be pre-set to seven different frequencies, any of which can subsequently be selected at will by the operator, and has a "FREE" position, in which the control knob can be rotated to any frequency within the range.

Construction

4. The construction of the mechanism is illustrated in fig. 27. It consists of two main assemblies, the click-lever assembly on the transmitter panel and the click-ring assembly on the control knobs.

5. The click-lever assembly consists of a cradle accommodating eight spring-loaded levers which ride on the periphery of a slotted octagonal cam. When the selector knob is turned to any one of its eight positions (seven are identified by letters and the eighth is labelled FREE) the cam rotates, and one lever at a time drops into its associated slot on the cam, the form of which prevents the remaining seven levers from dropping. Each of the seven front levers is notched, the eighth lever (at the back of the assembly) carries a cork-lined brake shoe and falls when the pointer of the selector knob is at FREE. On the compensating type of click-lever assembly (Stores Ref. No. 10D/973), a small compensating lever mounted in an eccentric bearing provides a means of moving the group of spring-loaded levers to and fro through a very small distance so that if the frequency of the transmitter has drifted slightly from that to which it was pre-set, the operator can make the small frequency correction necessary without interfering with the pre-set click-stop. This type is fitted to the M.O. control knob of the H.F. ranges and permits a variation of frequency of about 0.1%. On the non-compensating type (Stores Ref. No. 10D/974) this facility is not provided.

6. The click-ring assembly comprises seven separate rings, each having one projecting tooth shaped to fit into the notch on its associated selector lever. Locking screws, identified by letters embossed on the control knob, are provided, one for each ring. When a screw is tightened, the ring associated with it is held fast and rotates with the knob. Loosening the screw frees the ring and renders it independent of movements of the control knob. The ring controlled by each screw is positioned immediately below the lever which will fall when the selector knob pointer is turned to the corresponding letter; thus, when the selector knob points to G the lever G will fall. If the screw labelled G on the control knob is tight the ring can be turned with the control knob until the tooth on the ring clicks into position in the notch on the lever G. If the screw G is then loosened the ring will be held in position and the knob can be turned to any required frequency without disturbing the ring; by tightening the screw this frequency is pre-set, as the tooth on the ring controlled by the screw G will always click into the same position when the selector knob is turned to G again. With this type of click-stop mechanism there is no restriction on the proximity of adjacent frequency settings.

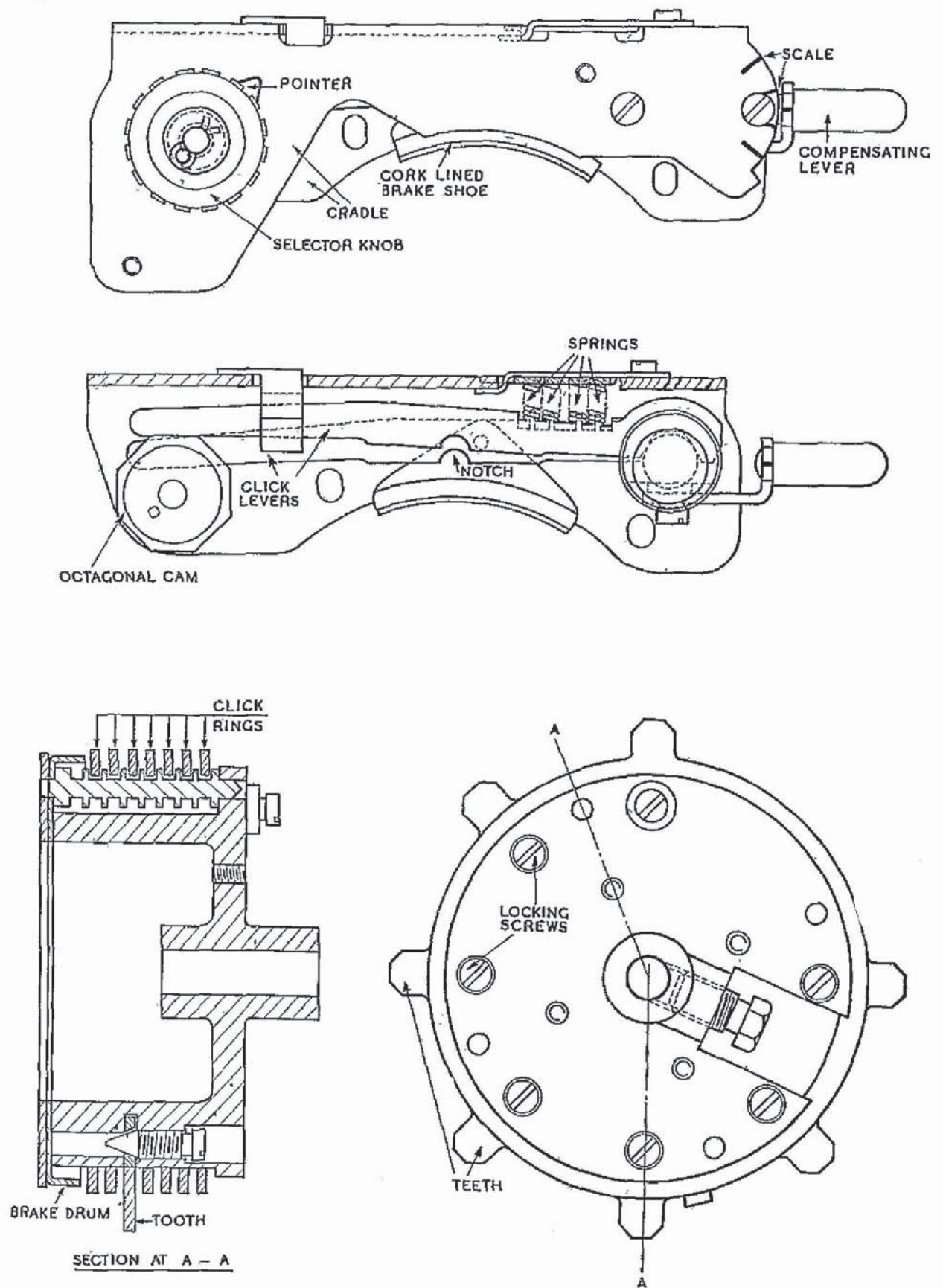


Fig. 27—Details of "Uni" click-stop mechanism.

Setting up the "Uni" click-stops

7. The mechanical operations involved for all controls are substantially similar, and for the sake of illustration it is assumed that it is desired to pre-set the M.O. to 10 Mc/s on click-stop G:—

- (i) Enter the frequency (10 Mc/s) in pencil in space G on the ivory table on the valve access panel.
- (ii) Set the compensating lever to the second mark, counting from the bottom, on its scale.
- (iii) Set the selector knob to G.
- (iv) Turn the M.O. tuning control knob until the tooth on the click-ring is felt to engage with the notch in the lever.
- (v) Loosen screw G on the control knob.
- (vi) Set the tuning control knob to the required frequency (10 Mc/s) using a crystal monitor where available or any standard method, e.g. wavemeter, back-tuning to R.1155, or by the scale on the tuning control knob itself.
- (vii) Tighten the locking screw G.

Tuning to a frequency which has been pre-set

8. Assuming that it is desired to tune the transmitter to 10 Mc/s, this frequency having been set up on click-stop G:—

- (i) Turn the selector knob to G.
- (ii) Turn the tuning control knob until the toothed ring is felt to engage in the notched lever.

Tuning to a frequency which has not been pre-set

9. (i) Turn the selector knob to FREE.

- (ii) Turn the tuning knob to the required frequency. The pressure of the friction brake is sufficient to prevent the knob moving out of position owing to the vibration of the aircraft.

Servicing

10. The cover plate, which provides a measure of protection against dust, should be removed and the working surfaces lubricated with anti-freezing oil. Particular attention should be paid to the bearing surfaces of the octagonal cam. Any dust or grit present should be removed before the oil is applied.

SECTION 1, CHAPTER 8

TRANSMITTER T.1115

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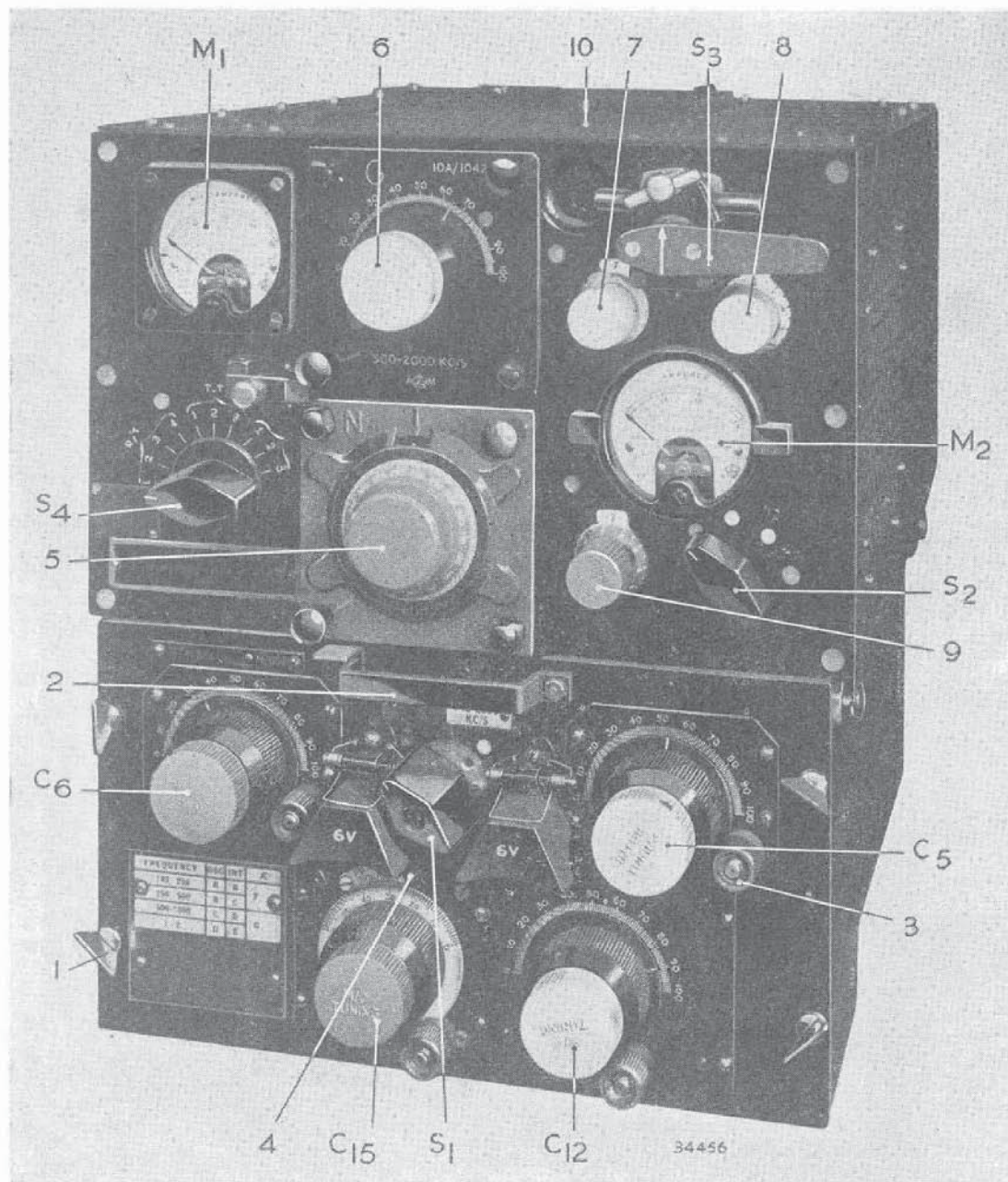
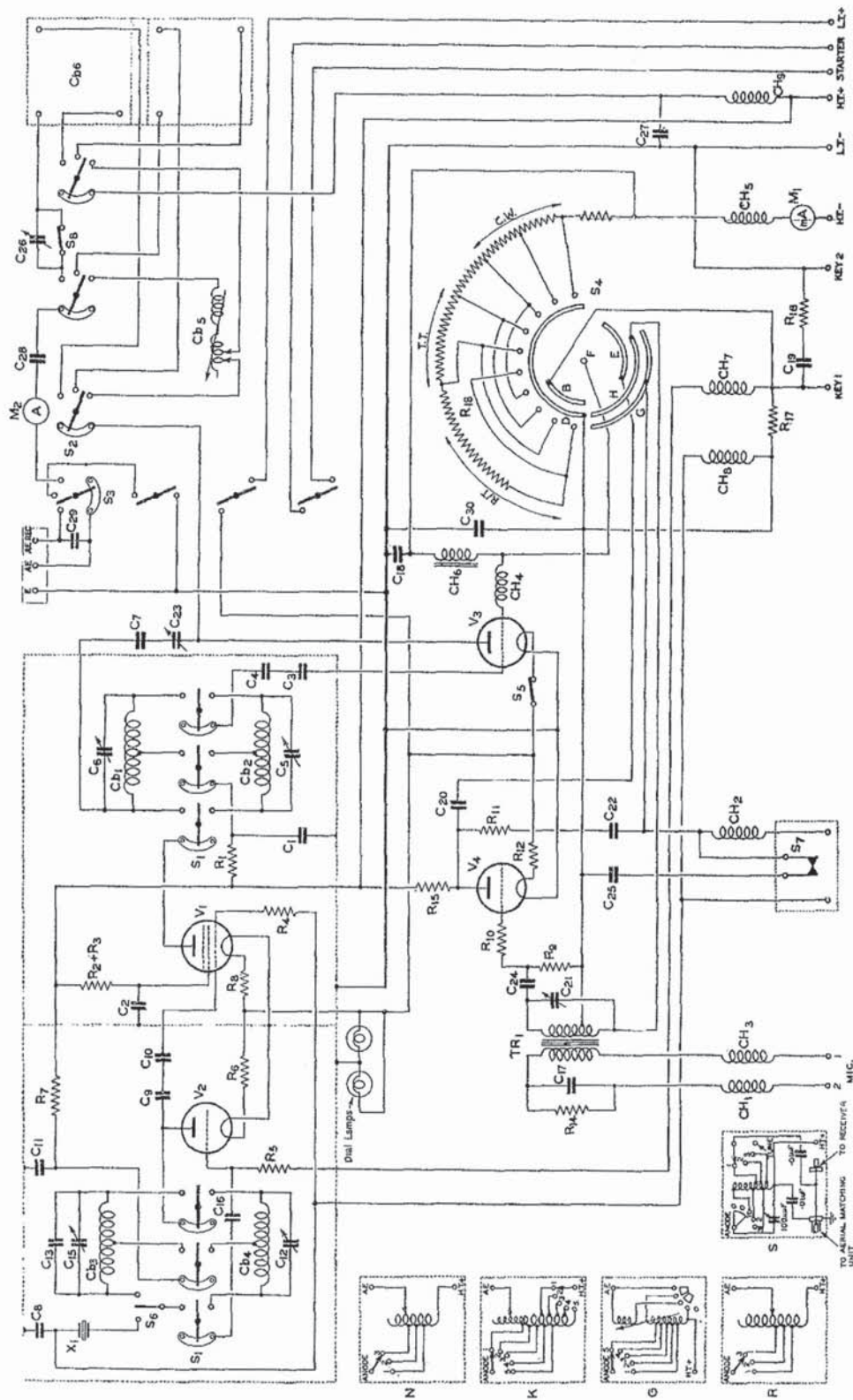


FIG. 1.—TRANSMITTER T.1115

C ₈	C ₁₃ C ₁₅ C ₁₂	C ₁₆	C ₁₁	C ₉	C ₁₀ C ₁₇	R ₆	C ₂	C ₂₄ C ₂₁	C ₂₅	C ₁	C ₆ C ₂₂	C ₅	C ₄ C ₃	C ₇ C ₂₃	C ₁₈	C ₂₉ C ₃₀	C ₂₆ C ₁₉	C ₂₆	C ₂₇
$R_5 \quad R_{14} \quad R_{15} \quad R_{16} \quad R_{17} \quad R_{18}$																			
X ₁ S ₁	C _{b3} C _{b4}	V ₂ CH ₁	TR ₁ CH ₃	R ₈ R ₉	R ₄ R ₅	R ₁ R ₂	R ₁₁ R ₁₂	C _{b1} CH ₂	C _{b2} CH ₃	S ₅	V ₃ CH ₄	S ₃ CH ₅	M ₂ S ₂	C _{b5} CH ₇	S ₄	S ₈	I	M ₁	C _{b6} CH ₉
CONDENSERS																			
RESISTANCES																			
MISCELLANEOUS																			



THEORETICAL CIRCUIT DIAGRAM, T.III.5.

FIG. 2

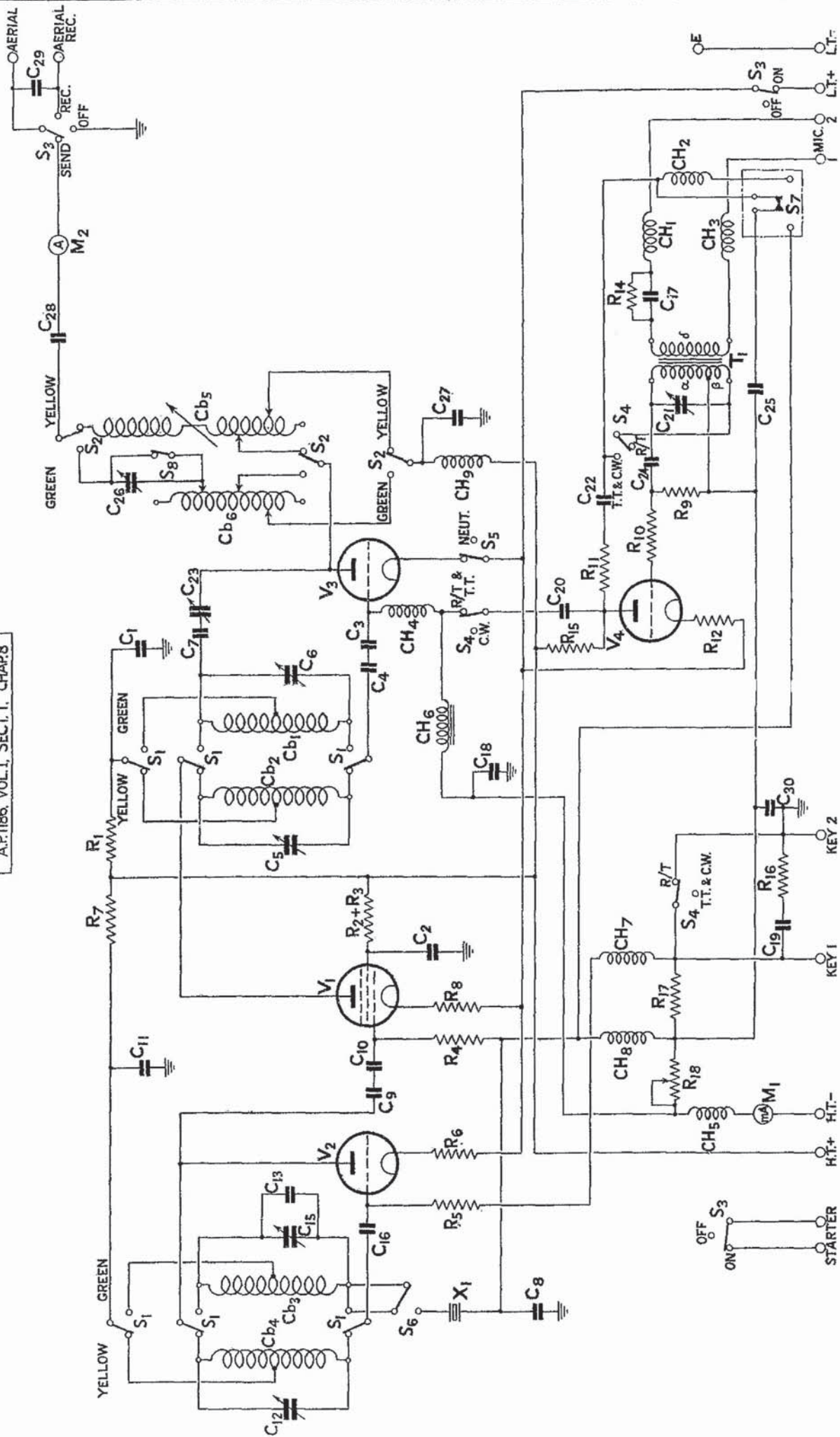


FIG. 3 SIMPLIFIED THEORETICAL CIRCUIT DIAGRAM

FIG. 3

FIG. 3

TRANSMITTER T.1115

(Stores Ref. 10D/10380)

INTRODUCTION

1. The transmitter, type T.1115, is a general purpose aeroplane transmitter covering the range of frequencies from 142 kc/s. to 20 Mc/s. It is designed for the transmission of C.W., I.C.W. and R/T. The particular form of I.C.W., or wave type A2, transmitted is that known as 'Tonic Train' (T.T.). Provision is made to vary the tone of I.C.W. signals by means of an external unit which is supplied for special installations.

2. The transmitter is normally installed in conjunction with the general purpose receiver R.1116. The association of these instruments provides for side-tone and intercommunication facilities, a potentiometer control in the receiver circuit pre-setting the necessary level for either service. Listening-through is available from a small fixed condenser in the transmitter aerial lead. The SEND-RECEIVE switch of the T.1115 is normally manually operated but can be adapted for remote control in special installations. The tone frequencies may be remotely controlled.

3. The transmitter circuit comprises a master-oscillator stage, an intermediate amplifier stage, operating as a frequency-doubler, an output amplifier stage and an audio-frequency stage. The last-named is used as a grid-modulator of the output amplifier, acting as an A/F amplifier for R/T and as an A/F oscillator for T.T. transmission. When transmitting in the 2 Mc/s to 20 Mc/s band, quartz crystal control may be utilized if desired. Even if crystal control is not used the circuit provides for a high degree of stability.

4. Simple switching arrangements have been provided to enable the instant selection of either of two "spot" frequencies, one in the 142 kc/s to 2,000 kc/s band and one in the 2 Mc/s to 20 Mc/s band. To provide for this arrangement the tuning circuits of each stage are duplicated. This requirement necessitates the provision of sixteen plug-in coils to cover the entire band. A further four coils are provided to cover two intermediate bands.

5. To facilitate operation a range and tuning control colour code has been instituted, this code being duplicated in the controls of the R.1116. The lower frequency, 142 kc/s to 2,000 kc/s band, controls are coloured YELLOW, and those of the higher frequency, 2 Mc/s to 20 Mc/s, band, GREEN.

6. The transmitter is specifically intended for use with carbon granule type microphones, for example, the mask microphone, type E. Arrangements may be made to use the electro-magnetic type of microphone but in this event an additional sub-modulating amplifier will be necessary to afford the requisite gain.

7. A general arrangement view of the T.1115 is shown in fig. 1. The weight of the instrument with the coil F, which is an integral part, and the coil G, which is normally carried, but without the other coils involved, is, approximately, 28 lb. 2 oz. The weight of the remaining coils is 6 lb. 15 oz. When the instrument is set up for operation on both the YELLOW and GREEN band of frequencies, the weight of the complete equipment, with the heaviest combination of coils, is 34 lb. The dimensions of the transmitter are 10 in. by 12½ in. by 13¾ in.

GENERAL DESCRIPTION

8. A complete theoretical circuit diagram of the transmitter T.1115 is given in fig. 2 and a simplified version in fig. 3. Identical annotational references have been used in these diagrams. It should be noted that, having regard to the use of interchangeable plug-in coil units in this instrument, the conventional inductance symbol utilized in the diagrams has been annotated as "Cb", or coil base, instead of as "L". The YELLOW, or lower frequencies, band is represented by Cb₄, Cb₂ and Cb₅, the GREEN, or higher frequencies, range by Cb₃, Cb₁ and Cb₆. The inductance Cb₅ represents the coil F which is permanently incorporated in the instrument.

9. The oscillator stage consists of a triode valve V₂ in association with a tuned circuit arranged as a series-fed Hartley-type oscillator. The tuned circuit is duplicated, the YELLOW range coil-condenser combination being Cb₄-C₁₂, the GREEN range being represented by Cb₃-C₁₅ with a parallel fixed capacitance of C₁₃. The desired circuit is selected by a switch S₁ which also switches the intermediate amplifier circuit.

10. The grid circuit of the valve V_2 incorporates a grid condenser C_{16} connected in series with the grid section of the tuned circuit coil. Grid bias is maintained by a grid leak resistance R_5 which is joined between the grid condenser C_{16} and the filament negative of V_2 through a R/F choke Ch_7 and, for R/T, a switch S_4 . Effectively, the resistance R_5 is in parallel with the capacitance of C_{16} and a by-pass condenser C_{11} . For T.T. or C.W. transmission the filament return path is *via* the keying circuit, which is bridged by a condenser C_{19} and a resistance R_{18} . The choke Ch_7 obviates the practical short-circuiting of the grid-filament path which would occur were it not included, and thus increases the excitation voltage.

11. The positive filament lead of the valve V_2 includes a resistance R_6 which is necessitated by the lower voltage requirements of the type V.T.45 valve employed. The anode supply is fed to the valve V_2 through a resistance R_7 and the anode section of the coil Cb_4 or Cb_3 . The power in the oscillator circuit is by this means limited to approximately two or three watts. The oscillator circuit determines a frequency which is one-half of the transmitted frequency, the highest frequency at which V_2 is called upon to function being, therefore, 10 Mc/s.

12. Facilities are provided for crystal control of the oscillator stage V_2 on the GREEN range of frequencies between 2 Mc/s and 20 Mc/s, if service requirements make the additional stabilizing element desirable. The circuit arrangement when crystal control is used is as shown in fig. 4. The crystal X_1 is inserted in a socket actuating a switch S_8 . The switch S_8 disconnects the tuned circuit from the grid condenser C_{16} . The crystal X_1 is then connected, in series with the condenser C_{16} and a by-pass condenser C_8 , between the grid and filament of the valve V_2 .

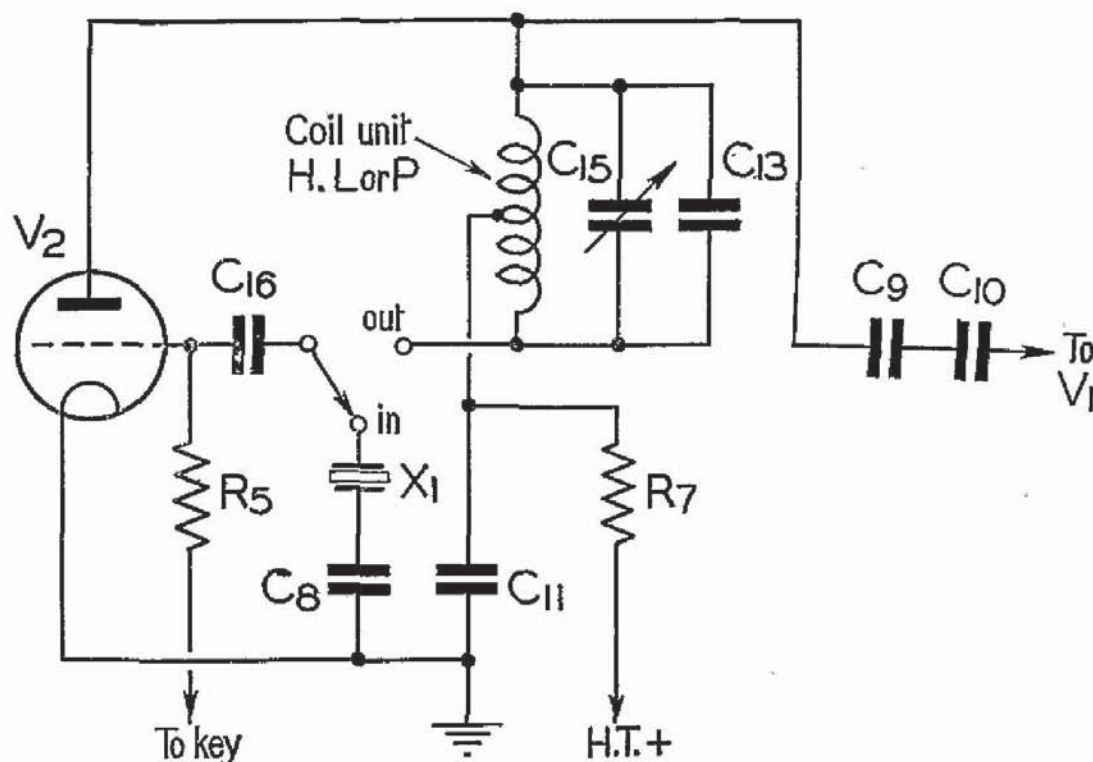
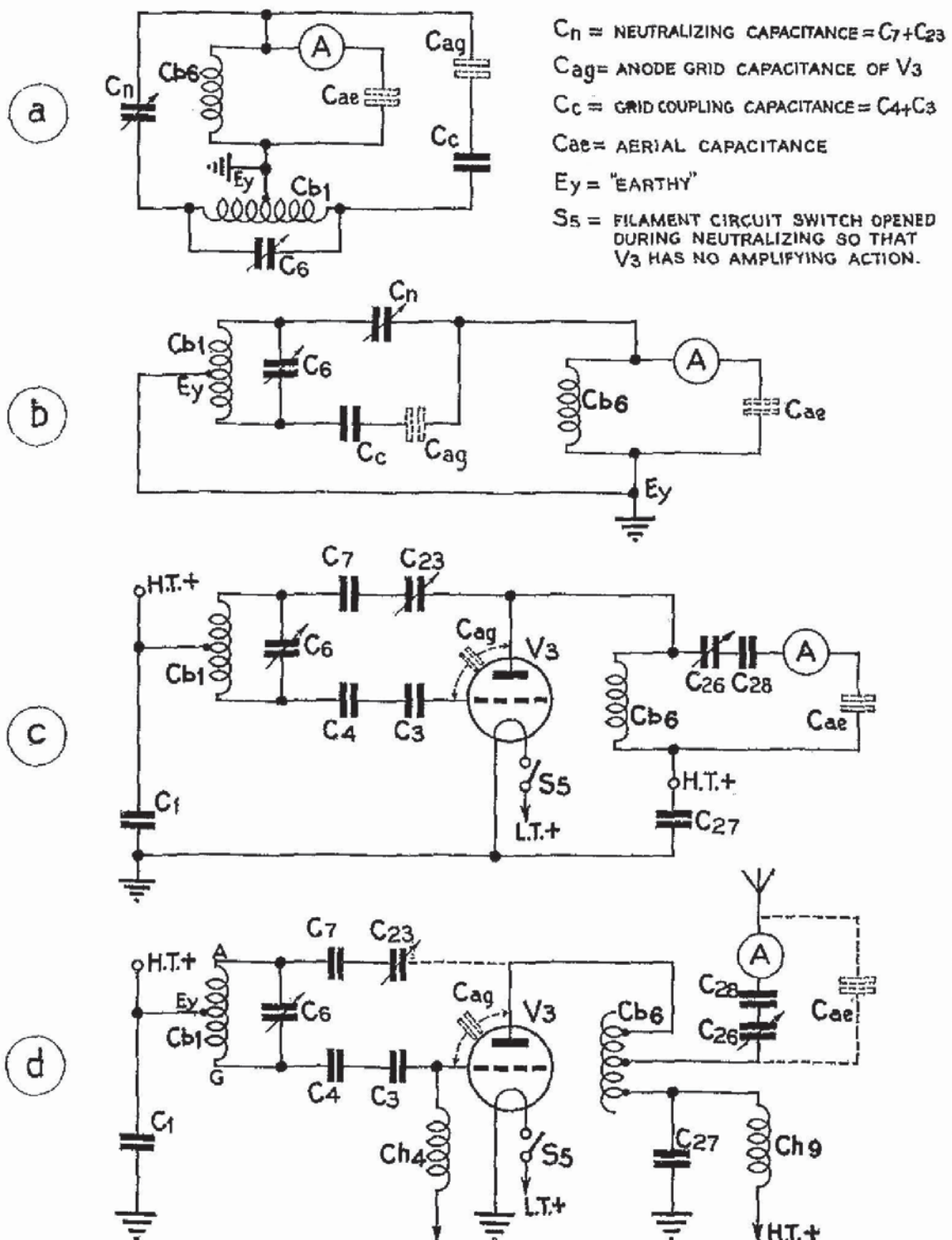


FIG. 4.—CRYSTAL CONTROL OF T.1115 IN GREEN BAND

13. The crystal-oscillator circuit is of the conventional type, the tuned anode circuit of the M/O with Cb_3 - C_{15} - C_{13} being retained. The necessary feedback is brought about by the internal anode-grid capacitance of the valve.

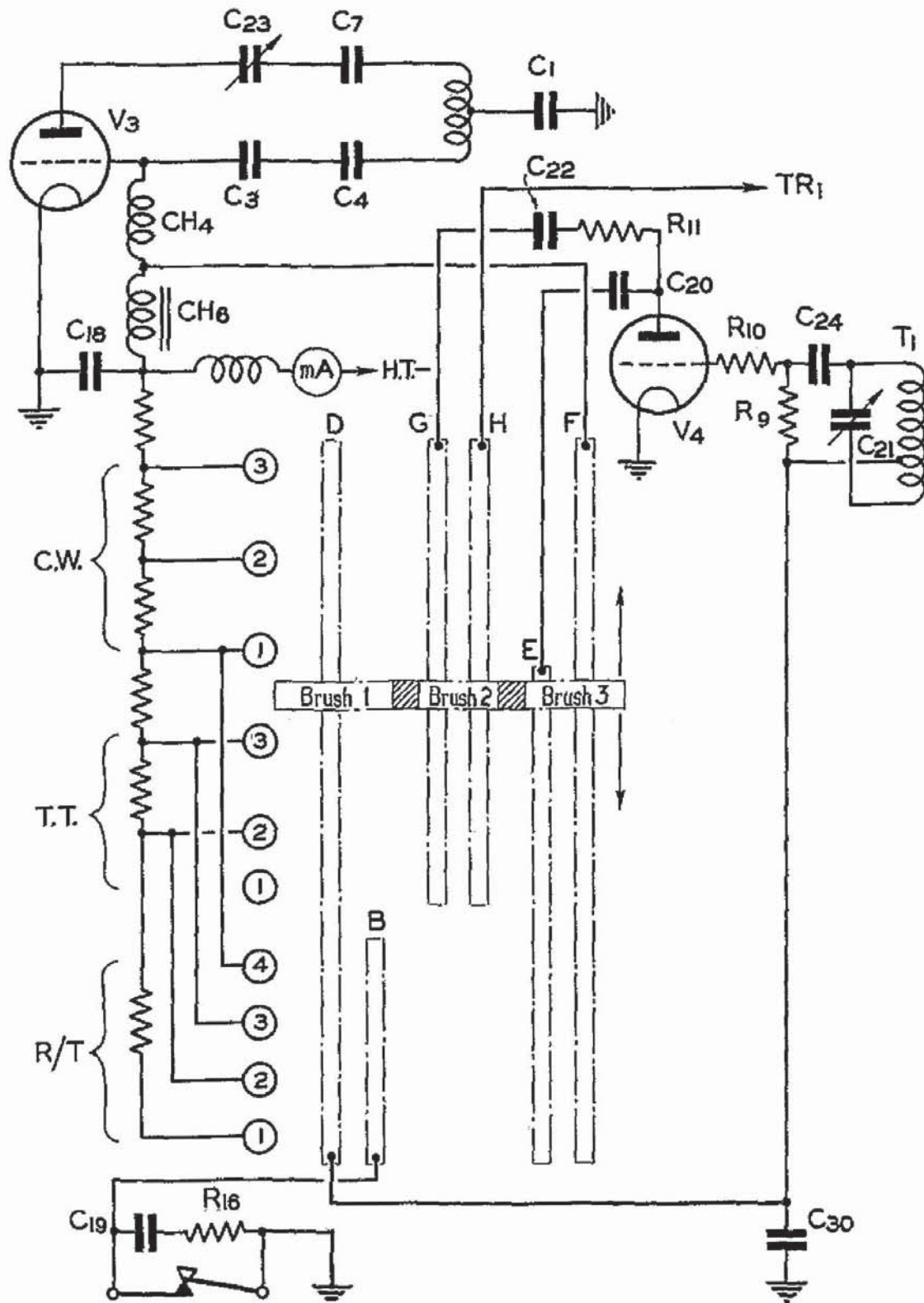
14. The output from V_2 is coupled to the intermediate amplifier and frequency-doubling pentode valve V_1 by a grid condenser C_{10} which has an air dielectric. In order to maintain the insulation resistance between the anode of V_2 and the grid of V_1 , in the event of a short-circuit occurring between the plates of C_{10} , a supplementary condenser C_9 , having a mica dielectric, is connected in series with C_{10} . This practice has been adopted in other parts of the transmitter circuit and the additional mica dielectric condenser will be referred to as a safety condenser.



NEUTRALIZATION OF OUTPUT STAGE, T.1115

FIG. 5

FIG. 5



BIAS SWITCH FUNCTIONAL DIAGRAM, T.1115

FIG. 6

FIG. 6

15. The control-grid bias of V_1 is maintained at a suitable value by a resistance R_1 . The valve is operated under Class A conditions. This class of amplification is not normally used in transmission practice but its choice was imposed by the desire to utilize the stage as a "buffer" between the oscillator and the output stages, preserving the oscillator from variations of load caused by fluctuating aerial condition. Further, although the anode efficiency is low, due to the operating characteristic, a low grid input produces a large voltage amplification. The curvature of the characteristic is sufficiently marked to provide ample second harmonic excitation to drive the succeeding stage without the necessity of accentuating this harmonic output by extreme negative grid biasing:

16. The tuned anode circuit of the valve V_1 is constituted by a coil Cb_3 with a variable condenser C_5 for the YELLOW range and a coil Cb_1 with condenser C_6 for the GREEN range. These circuits are tuned to the frequency to be transmitted, which is the second harmonic of the oscillator frequency of the stage V_2 . The coils Cb_2 and Cb_1 are fed at their centre-point through a resistance R_1 , a separate mains condenser C_1 being provided. The power is limited by R_1 to approximately 15 watts.

17. The screening electrode of the pentode V_1 is connected to the H.T. positive supply terminal via a joint feed resistance consisting of R_2 and R_3 . The R/F potential of the screen is maintained sensibly constant and equal to that of the filament, by a condenser C_2 . The filament positive line incorporates a resistance R_8 . Having regard to the frequency of the output circuit of V_1 , that is Cb_3-C_{15} and Cb_1-C_6 , differing from the frequency of the input circuit no neutralization of the stage is necessary.

18. The output circuit of V_1 is coupled to the grid and filament of a triode valve V_3 by a grid condenser C_3 with a safety condenser C_4 in series with it. As the filament of the type V.T.47 valve, V_3 , requires the full 6 volts from the L.T. battery no series resistance is provided. A switch S_5 is incorporated in the filament positive lead for use in neutralizing.

19. The output circuits of the stage V_3 consists of a tuning coil, which is Cb_5 for the YELLOW range, and Cb_6 for the GREEN selected by a switch S_3 . The capacitance for these circuits is formed by the aerial capacitance, an aerial blocking condenser C_{28} and, additionally, on the GREEN range, a series variable condenser C_{26} which is short-circuited by a switch S_6 when rotated beyond its maximum position. The condenser C_{26} is included to enable the transmitter to work into an aerial having an inductive reactance. A thermoammeter M_3 indicates aerial current. The tuned circuit is series-fed through a R/F choke CH_9 and the switch S_2 . A mains condenser C_{27} is provided.

20. The input circuit and the output circuit of V_3 are tuned to the same frequency and are coupled together by the grid-anode capacitance of the valve. The stability of the stage renders neutralization unnecessary on the YELLOW band of frequencies, but for the GREEN band simple neutralization is arranged and once this is effected it will hold over a wide frequency range.

21. Grid neutralization is employed, the out-of-phase neutralizing voltage being obtained from the centre-tapped grid coil Cb_1 . The simplified diagrams of fig. 5 show the manner in which neutralization has been evolved from a basic "bridge". If we assume that R/F oscillation exists in the aerial circuit Cb_3-C_{ae} , at any given moment the anode of V_3 is at some particular potential with respect to the centre-point of the coil Cb_1 which is near earth potential and is, accordingly, marked E_y in the diagrams. Suppose the capacitance of $C_7 + C_{23}$ to be zero.

22. A potential is applied between the end G of Cb_1 and the "earthy" centre-point, through the capacitance of C_{ag} and $C_4 + C_3$ in series. If however the capacitance of $C_7 + C_{23}$ is equal to that of C_{ag} and $C_4 + C_3$ in series, an equal potential will be applied simultaneously between the end A of Cb_1 and its centre-point. Hence the oscillatory voltages across the output circuit Cb_3-C_{ae} do not cause a difference of potential between the ends A and G of Cb_1 . Since the above reasoning holds for any particular potential of the anode, it holds for all possible potentials and, in consequence, the stage is neutralized.

Keying and grid bias

23. For W/T signalling, excitation keying is employed, the morse key being connected to the terminals KEY 1 and KEY 2 in a "break-in" circuit with a key-click filter arrangement. The former terminal is connected to the grid circuit of the oscillator valve V_2 through the R/F choke CH_7 and the resistance R_5 . Through a resistance R_{17} , forming part of a variable bias resistance R_{18} and the choke CH_8 it is connected to the resistance R_4 on the grid circuit of the amplifier-frequency-doubler valve V_1 . The terminal KEY 2 is directly connected to the L.T. negative. When the key is depressed, therefore, the grid circuits are completed to the common L.T. negative.

24. The terminal KEY 1 is also connected through R_{17} , the variable bias resistance R_{18} , a R/F choke CH_8 and a milliammeter M_1 to the H.T. negative terminal. When the key is depressed the anode circuits of all three valves V_2 , V_1 and V_3 are therefore completed, the total electronic current flowing from L.T. negative to H.T. negative via the path already traced.

25. The grid circuit of V_3 , consisting of a R/F choke Ch_4 and an A/F choke Ch_6 is connected to the H.T. negative line at a certain point so chosen in the above path that a definite amount of negative bias is applied. The magnitude of this bias is equal to the product of the total anode current and the sum of the resistances $R_5 + R_{18} + R_{17}$. As R_{18} is variable, the grid bias of the class C power amplifier is regulated according to requirements by adjusting this resistance.

26. Incorporated in the bias resistance R_{18} there are three switch sections of a ten-point switch S_3 , these being indicated in the complete theoretical circuit diagram of fig. 2 as BD, EF and GH. The switch section BD is closed for R.F. operation only, when, in effect, it short-circuits the morse key, maintaining the anode and grid circuits of the four valves in a closed condition. The fourth valve is a triode V_4 serving a dual function which will be discussed in subsequent paragraphs. The switch section EF is closed for R/T and T.T. operation, while the section GH is closed for C.W. and T.T. operation.

27. The method in which the bias switch controls the type of signalling is more simply illustrated in fig. 6 which shows three brushes 1, 2 and 3 attached to the bias switch arm. Vertical movement of these brushes corresponds to actual rotation of the switch arm. The fixed contacts D and B, G and H, and E and F, are arcs of different lengths and positions as shown in fig. 2.

28. The brush 1 is permanently in contact with D and connects it to the selected bias tap. In the R/T positions brush 1 connects D and B to short-circuit the morse key. The brush 2 connects G and H in T.T. and C.W. positions to complete the modulated transmissions, thus connecting the modulator anode through C_{20} to the grid of V_3 .

The modulator stage

29. In the simplified diagram which is fig. 7, there are shown those parts of the circuit which are connected with modulation. Components to the right of the broken line are situated in the receiver R.1116. The interconnexion between transmitter and receiver will be dealt with more fully in subsequent paragraphs. It will be obvious from a study of the diagram that this transmitter cannot properly be used alone for the transmission of R/T.

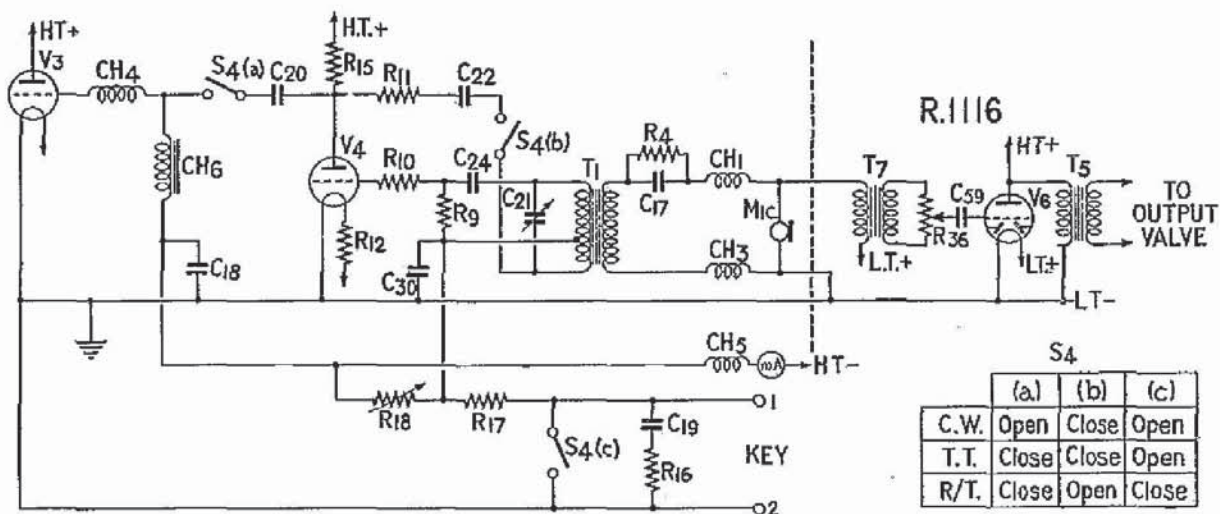


FIG. 7.—THE MODULATOR STAGE, T.1115

30. The filament of the modulator valve V_4 is heated from the common L.T. battery, a resistance R_{12} being incorporated in the negative lead. The output circuit comprises an anode blocking condenser C_{30} and the choke Ch_6 , this anode circuit being parallel-fed through a resistance R_{15} . The input circuit to V_4 is constituted by a microphone transformer T_1 having a split secondary winding of which only a fraction, represented by the winding α is applied to the modulator input. The ratios of the primary winding δ , secondary winding α and reaction winding β are as 1 : 37 : 3.

31. Assuming that the microphone and battery, which is actually the R.1116 battery, are connected to the primary winding of T_1 via the chokes Ch_1 and Ch_3 , it will be appreciated that, when the switch sections EF and BD are closed, the voltage developed across the winding α is applied, via a condenser C_{24} to the grid of V_4 . Amplified voltages are accordingly developed in the speech choke Ch_6 and are applied to the grid-filament path of the power

amplifier valve V_3 . This valve also obtains R/F grid-filament excitation from the circuits Cb_1-C_6 and Cb_2-C_5 and the operating conditions are those of a grid-modulated class C amplifier.

32. The grid condenser C_{24} is inserted in order to attenuate the lower audio-frequencies and so to prevent the transmission of the external noise prevalent in an aeroplane in flight. A resistance R_{10} acts, in conjunction with the valve input capacitance, as a R/F grid-stopper preventing the R/F from reaching the modulator valve. The inclusion of the condenser C_{24} necessitated the introduction of a grid leak resistance R_9 . In the primary circuit of the transformer T_1 a condenser C_{17} with a resistance R_{14} in parallel, are included. These are required for the interconnexion with the receiver R.1116 and will be referred to in para. 38.

Tonic train

33. When the switch sections EF and GH are closed, the anode circuit of the modulator valve comprises two parallel paths. The first of these, namely that *via* R_{15} has previously been mentioned. The second consists of R_{11} , C_{23} and the reaction winding β of T_1 . The coupling between winding δ and the secondary winding α of T_1 which is included in the grid circuit, and the suitable values of the circuit constants causes the valve to oscillate at an audio frequency. Resulting voltages set up in the speech choke Ch_6 effect modulation of the output of the power amplifier V_3 as in the case of R/T transmission. Since the switch section BD is open the oscillations are key-controlled.

C.W. side-tone

34. The switch section GH is closed during C.W. transmission also, though the section EF is open. The valve V_4 therefore maintains an A/F oscillation during the periods in which the key is depressed during the time of transmission. By suitable connexions to the receiver R.1116 this A/F note may be caused to operate the telephones and so provide a C.W. side-tone. This method of connexion will be dealt with subsequently.

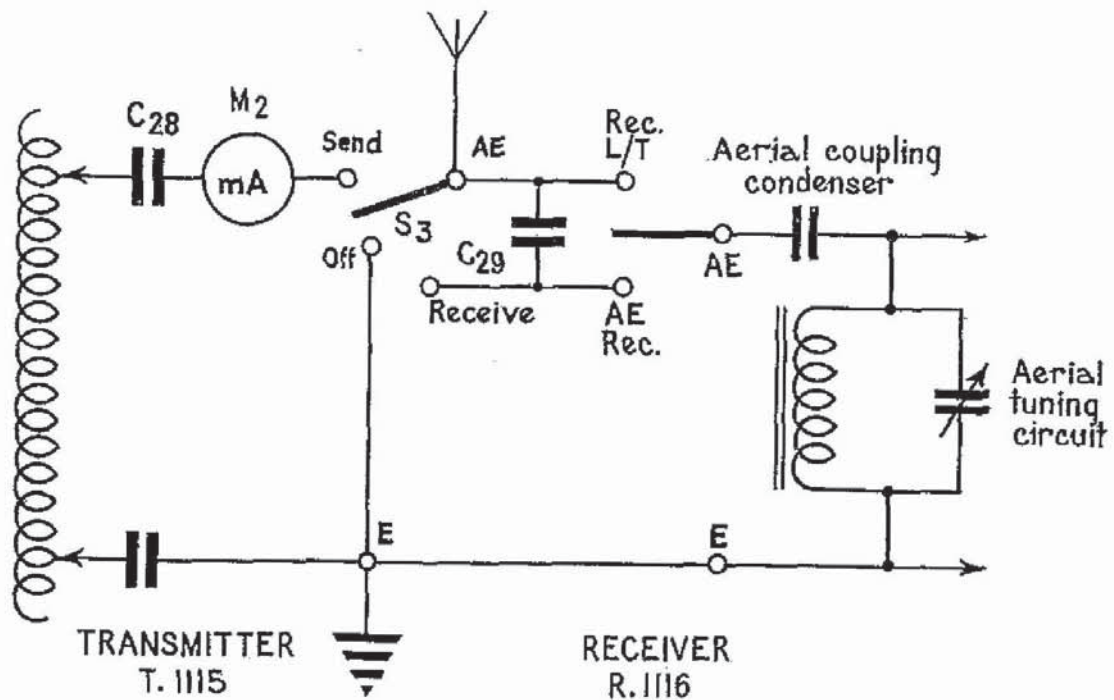


FIG. 8.—AERIAL CIRCUIT CONNEXIONS OF T.1115 AND R.1116

Interconnexion of T.1115 and R.1116

35. The transmitter switch S_3 has three positions SEND, OFF and RECEIVE. In the SEND position the aerial is connected to the transmitter, and may also be coupled to the R.1116 through a listening-through condenser C_{29} . The transmitter filaments are ON and the relay bobbin of the starter is made. In the RECEIVE position the aerial is connected to the receiver and the transmitter H.T. and L.T. are OFF. In the OFF position the aerial is earthed. The diagram of fig. 8 shows the interconnexion of the aerial circuits T.1115 and R.1116.

Listening-through

36. The receiver aerial lead may be brought to either of two terminals on the transmitter. The terminal so marked gives a listening-through circuit when S_3 is at SEND. If, however, the switch is put to RECEIVE the aerial is coupled to the receiver through C_{23} and the transmitter tuned circuit is disconnected. This gives a free receiver circuit in which the pick-up of the aerial is slightly reduced by C_{30} . Listening-through is only possible with transmitter and receiver on the same frequency.

Intercommunication

37. The audio-frequency circuits of the T.1115 and R.1116 are inter-connected as shown in the simplified diagram of fig. 9. The microphone is energized by the 2-volt L.T. battery of R.1116, in series with the high impedance primary winding of the receiver I/C transformer. The secondary winding of this transformer is connected through a pre-set volume control, to the grid of the diode-triode valve. Speech voltages from the microphone are thus applied to the receiver A.F. amplifier for I/C. Refer to the chapter on the receiver R.1116 to be found elsewhere in this publication.

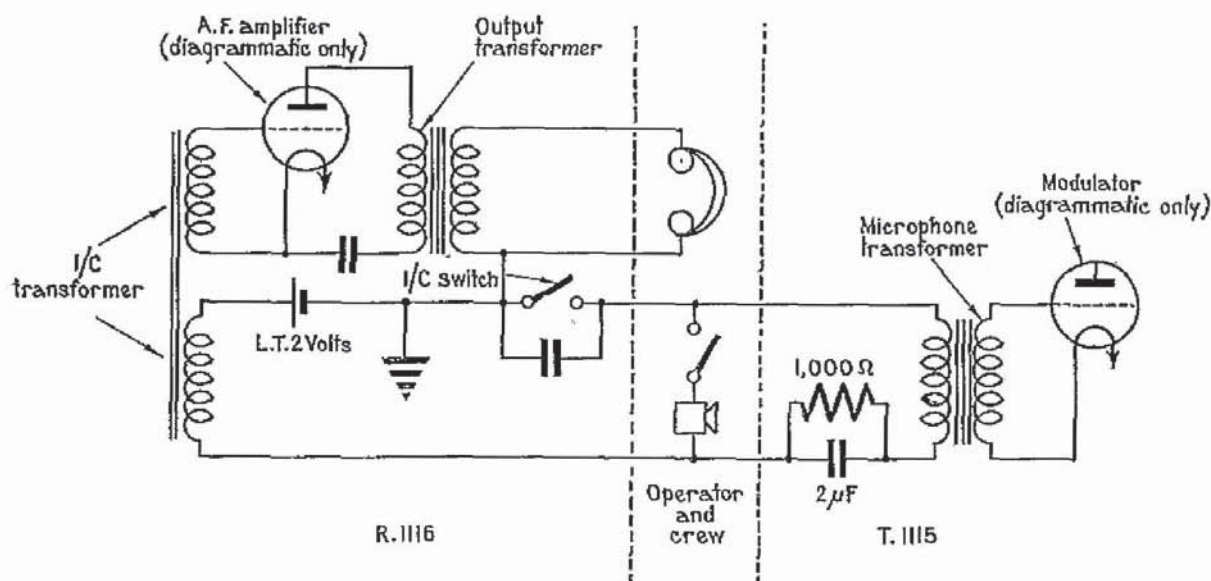


FIG. 9.—INTERCOMMUNICATION AND SIDE-TONE IN T.1115 AND R.1116

38. The primary of the transmitter microphone transformer T_1 is shunted across the primary of the receiver I/C transformer. The high step-up ratio of T_1 has already been mentioned in connexion with modulation. The primary is, in consequence, of comparatively low resistance and would seriously load the R.1116 I/C transformer were it not that the resistance R_{14} and the condenser C_{17} are included in the primary circuit.

Side-tone

39. When the T.1115 is arranged for R/T the microphone works into both transmitter and receiver, modulating the transmitter and providing R/T side-tone in the receiver. A similar circuit is used when the transmitter is arranged for T.T. and C.W. The microphone is then switched off but the valve V_4 is oscillating and speech frequency voltage is applied *via* the microphone transformers and I/C transformer to the A.F. amplifier of R.1116.

CONSTRUCTIONAL DETAILS

Transmitter, T.1115

40. Several views of the transmitter T.1115 are given in figs. 1, 10, 11, 12, 13, 15 and 16. The instrument comprises two members, a top member and a bottom member, held together by four coin-slotted screws. A bench wiring diagram of the bottom member is shown in fig. 14 and a corresponding diagram for the top member in fig. 17.

41. Referring to fig. 1, which is a view of the T.1115 from the front, the various controls and instruments are indicated. The bottom member tray slides into a casement from which it may be removed by releasing four wing nuts (1). To facilitate removal a handle (2) is provided. The

four tuning condensers C_6 , C_{15} , C_5 and C_{12} are controlled by two-speed knobs having a 14 : 1 reduction. The knobs are provided with locking devices (3). The lower and upper frequency band switch positions and tuning controls are engraved YELLOW and GREEN respectively.

42. The design of the oscillator tuning condenser C_{15} for the GREEN band, deserves attention. As the knob is rotated clockwise, from 0° to 120° , the fine adjustment portion of the condenser increases continuously in capacitance. On passing from 120° to 0° in a counter-clockwise direction the capacitance of the coarse adjustment portion is increased by a fixed step of approximately $30 \mu\mu\text{F}$, equal to the maximum of the fine adjustment portion. The number of steps is indicated in the window (4).

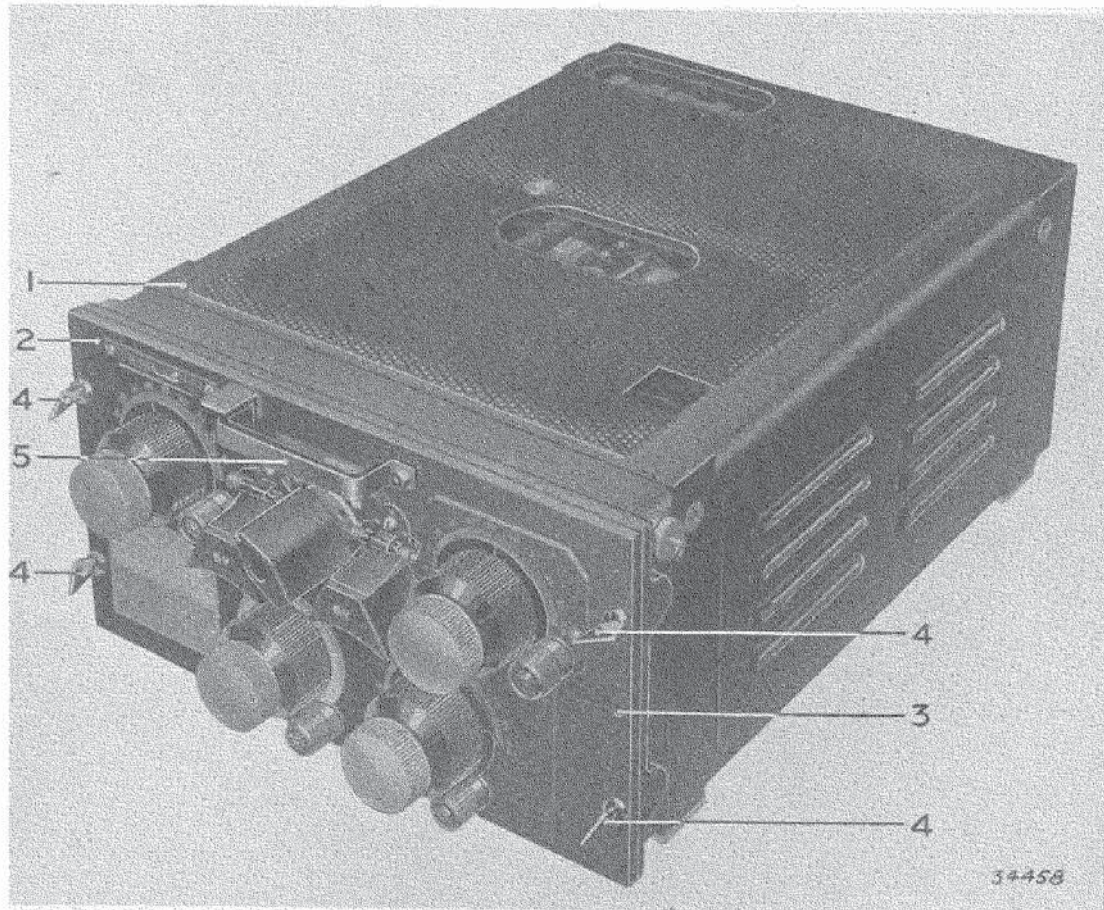


FIG 10.—BOTTOM MEMBER, TRAY IN CASE

43. The approximate tuning position of the aerial circuit is obtained by the control (7) or (8) when the coil F is used and by the control (6) when coil G is used, or by the controls (5) and (9) when coils J, N or R are used. Access to the neutralizing condenser C_{23} and filament switch S_5 is obtained by sliding back the cover (10) on the top of the transmitter.

44. The bottom member contains the oscillator and intermediate amplifier stages. It is shown, with the tray in case, in the illustration which is fig. 10. It consists of a cast aluminium case (1) in which slides a cast tray (2) bearing all the electrical components. The tray is located in the case by studs (3), or dowels, and is secured in position by four non-removable thumb screws (4). After slackening these screws and withdrawing the bottom member, by means of the handle (5), it then appears as shown in fig. 11.

45. The front part (1) of the tray houses the master-oscillator and its alternative tuned circuit; the rear compartment (2) contains the intermediate amplifier. When crystal control is used, the crystal holder is plugged into position on the platform (3) the necessary connexions being made by the pins (4) and (5). The pin (5) operates a switch S_6 . The crystal holder is locked in position by a screw (6).

46. In the underside view, fig. 12, which shows the bottom member without coils or valves, the coil socket (1) accommodates the YELLOW range M/O coil; the socket (2) takes the equivalent intermediate amplifier coil. The GREEN range M/O coil is inserted in the position (3) which carries the necessary pins. The GREEN intermediate-amplifier coil is positioned on the four-pin platform (4). Locking screws (5) for the coils are shown.

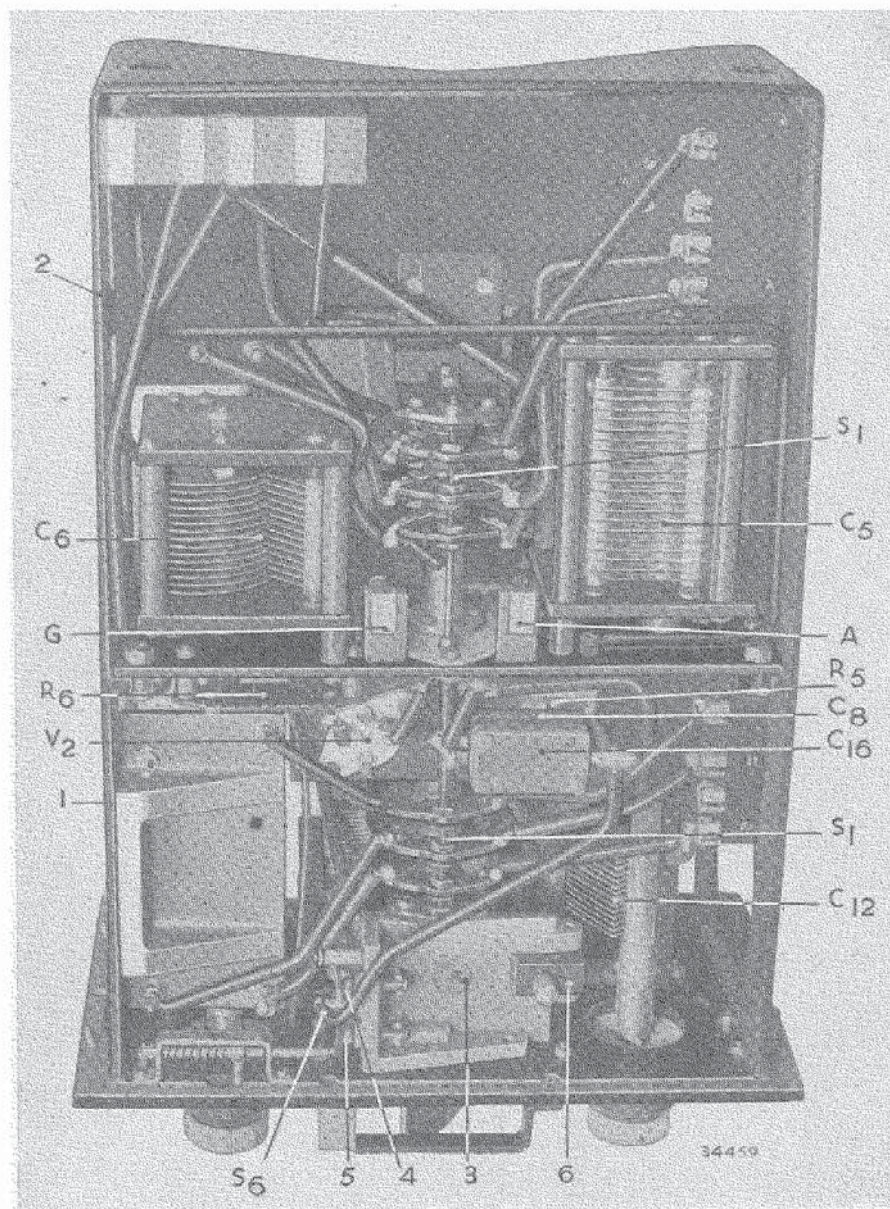


FIG. 11.—BOTTOM MEMBER, UPPER-SIDE VIEW

47. An asbestos-covered clamp (6) holds the oscillator valve in position. The condensers C_{12} and C_{15} effect fine tuning of the YELLOW and GREEN bands respectively. The fine adjustment portion of C_{15} is indicated as (7), the coarse adjustment portion as (8). The oscillator wave-change switch S_1 selects one of the two tuned circuits. The switch rod is prolonged into the intermediate amplifier compartment. The oscillator valve socket (9) and the intermediate amplifier valve socket (10) are also indicated.

48. In fig. 13 all coils, with the exception of the YELLOW range M/O coil, and the valves have been inserted in position. The annotations of this illustration accord with those of fig. 12. The position (3) is now occupied by the GREEN range M/O coil L (5 Mc/s-10 Mc/s) and position (4) by the corresponding intermediate-amplifier coil M. A bench wiring diagram of the bottom member is shown in fig. 14.

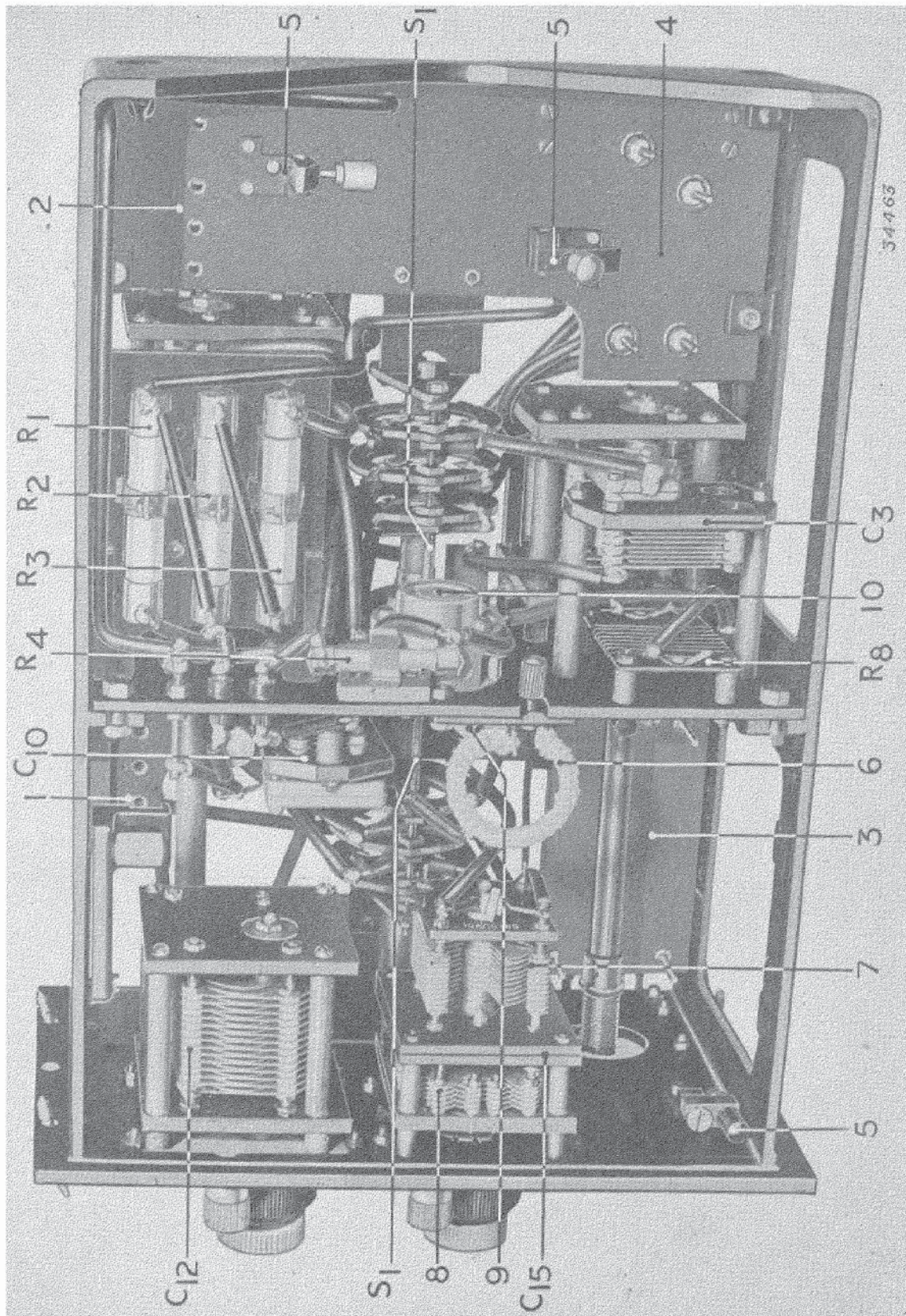


FIG. 12.—BOTTOM MEMBER, INTERIOR, UNDER SIDE VIEW

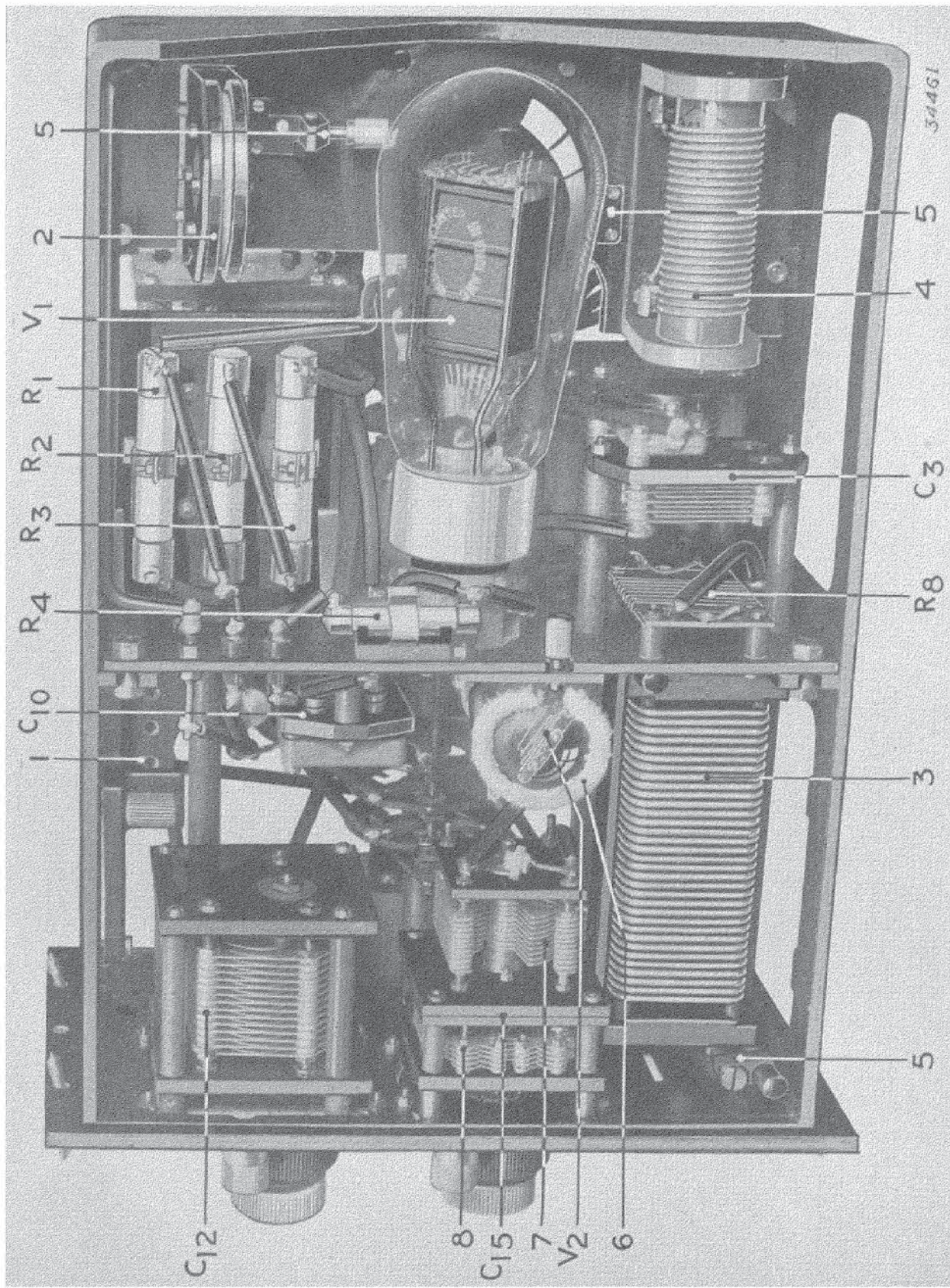


FIG. 13. BOTTOM MEMBER, UNDER-SIDE VIEW WITH VALVES AND COILS

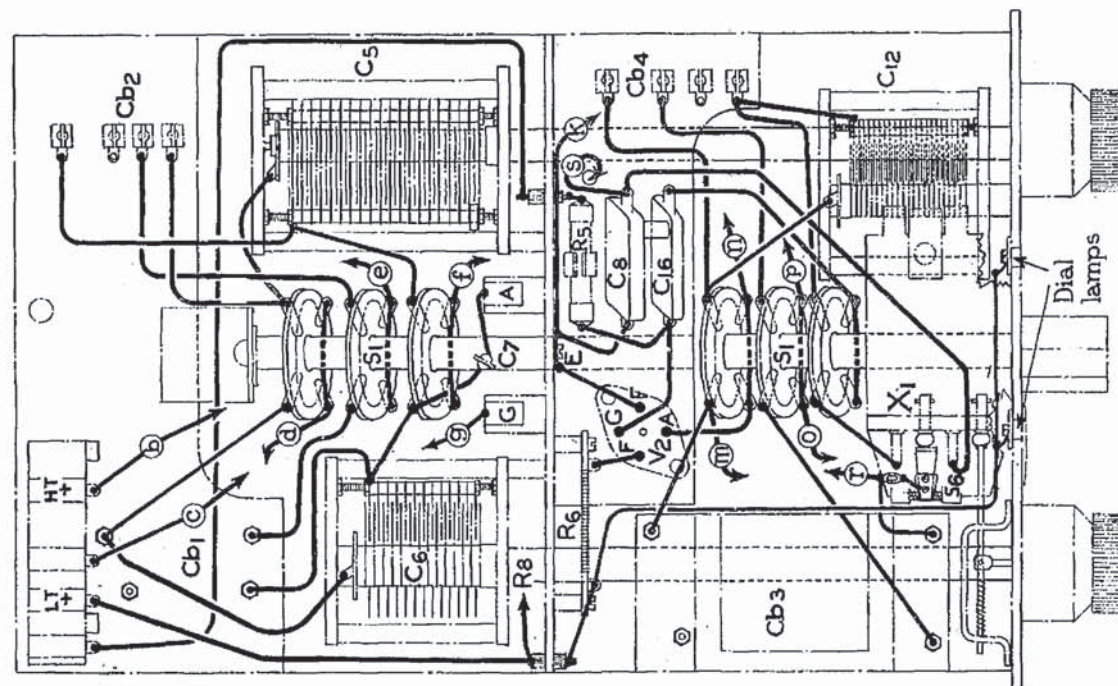


FIG.14

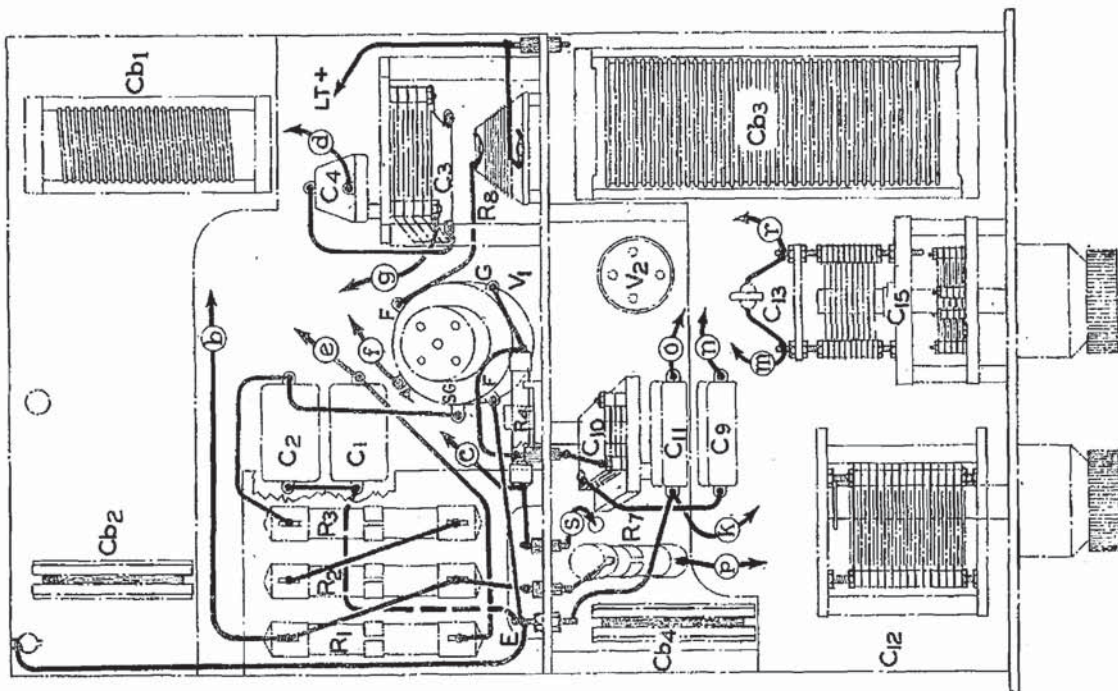


FIG.14

BENCH WIRING DIAGRAM, BOTTOM MEMBER

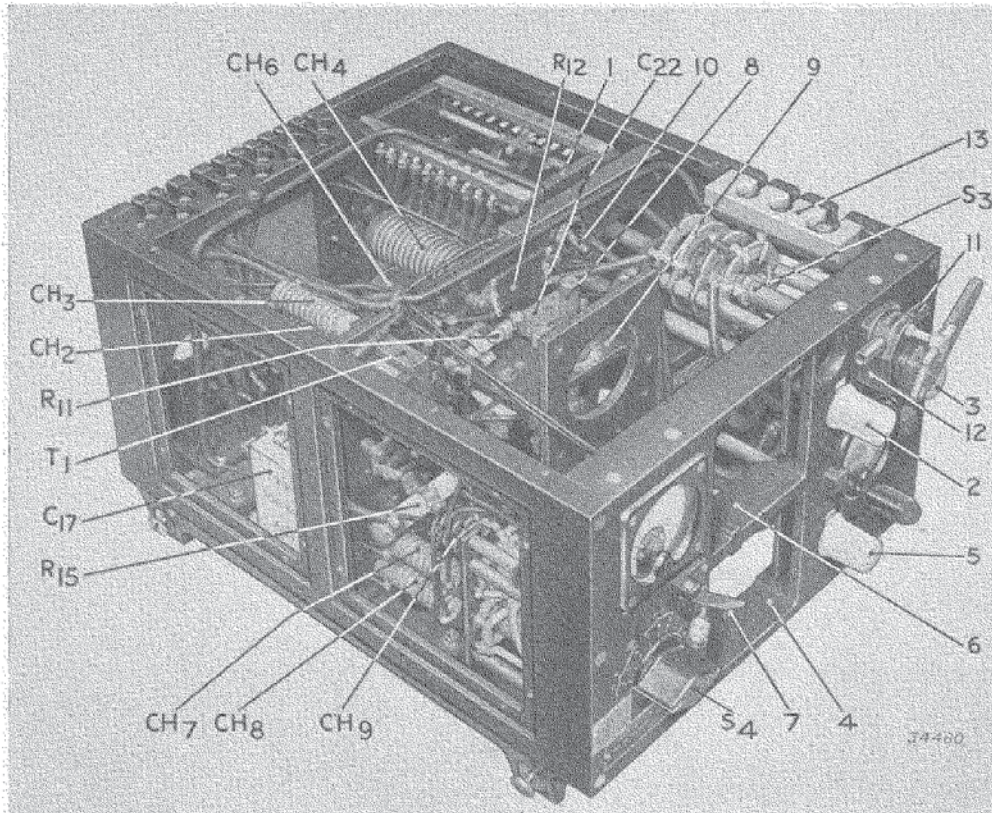


FIG. 15.—TOP MEMBER, TOP AND SIDE PANELS WITHDRAWN

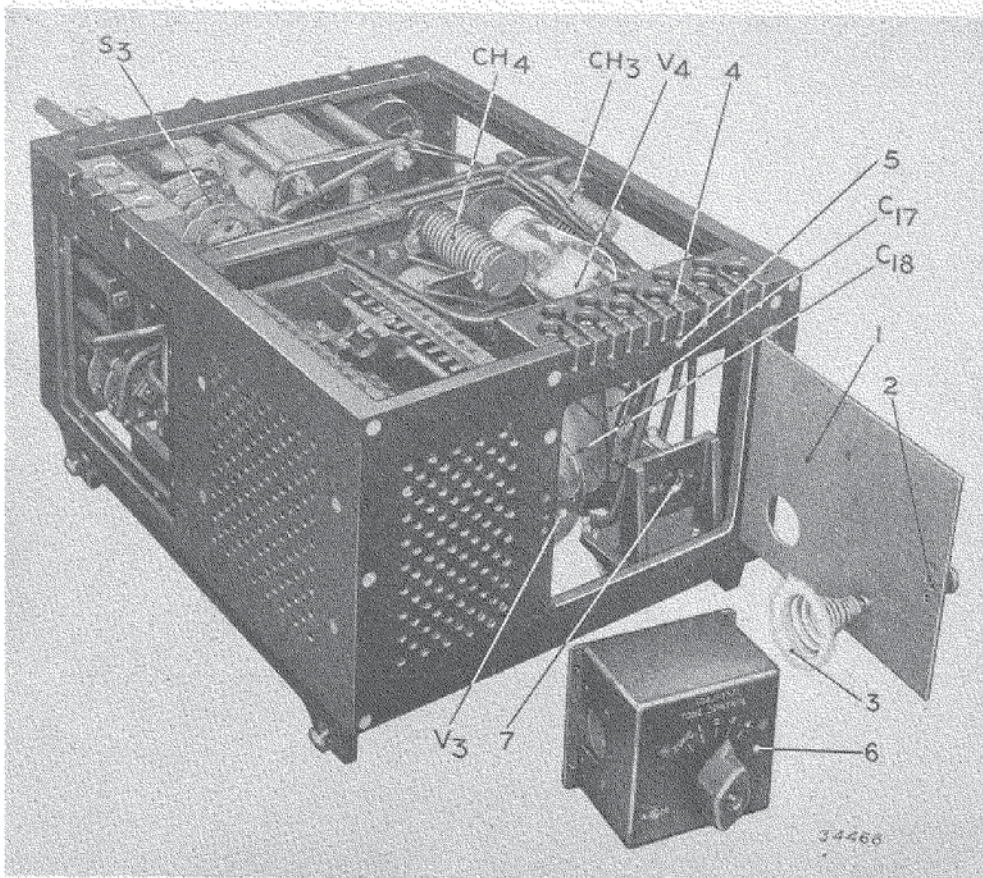


FIG. 16.—TOP MEMBER, REAR VIEW WITH TONE CONTROL UNIT

49. The top member contains the aerial and output stages with the modulator and is shown in fig. 15. On the YELLOW band the coil F, which is built into the instrument, is used below 500 kc/s. Coarse tuning is effected by the tapping switch (1) having ten positions, each with a corresponding anode tap, and is driven by the knob (2). The knob has a counting mechanism (see fig. 1) to indicate the tapping in use. For fine tuning there is a variometer inside coil F and this is driven, through a worm drive, by a knob (3). The position of the knob (3) is indicated in turns and tenths (see (8), fig. 1).

50. Between 500 kc/s and 2,000 kc/s the aerial circuit is tuned by a variometer, which is the coil G (6, fig. 1), and this is always carried in the transmitter but must be withdrawn to adjust the switches behind it (see (1), fig. 19). On the higher frequency (GREEN) band the aerial circuit is tuned by a coil L, N, or R which is plugged in to the lower recess (see (4), fig. 15). The coil N is seen in this position at (5) in fig. 1. This coil is tuned by a series condenser C_{26} driven by a knob (5). When the knob is turned fully clockwise this condenser is short-circuited.

51. The coils inserted in the positions (4) and (5) are secured by a catch (7). The knurled knob (8) controls the neutralizing condenser C_{23} of which the scale (9) is visible. The switch (10) mounted beside the knob (8) is the output valve filament switch S_3 . The bias switch S_4 has ten positions and behind it there is the microphone transformer T_1 .

52. The SEND-OFF-RECEIVE switch S_3 , may be remotely controlled and when this method is adopted the guide tube shafting (11) is engaged with a pinion in the housing (12) and may be taken off in either direction. The terminal block (13) has three terminals which, reading from front to rear, are engraved AERIAL, RECEIVER AERIAL and EARTH. This engraving may be discerned in fig. 16, which represents the rear view of the top member.

53. The output valve V_3 can be seen in fig. 16. This valve may be withdrawn by releasing the door (1) secured by a screw (2). The door carries an asbestos covered helical-spring steadying device (3) for the output valve. The modulator valve V_4 is also inserted in position through the door (1).

54. The input terminal block (4) engraving can be clearly seen in fig. 16. The blank terminal (5) between M.1 and M.2 represents the centre-point of the microphone transformer primary which is used in certain transmitters in connexion with tone control. The tone control unit (6) (Stores Ref. 10A/10571) which is used in certain circumstances is illustrated in fig. 16. It is fitted with five condensers and when connected, by a plug connector, to the socket (7), provides five A.F. notes having, approximately, the following frequencies:—

Zone, or high note:	1,850 cycles per second
Low note 1:	1,000 cycles per second
Low note 2:	750 cycles per second
Low note 3:	650 cycles per second
Low note 4:	550 cycles per second
Low note; with plug withdrawn:	1,460 cycles per second

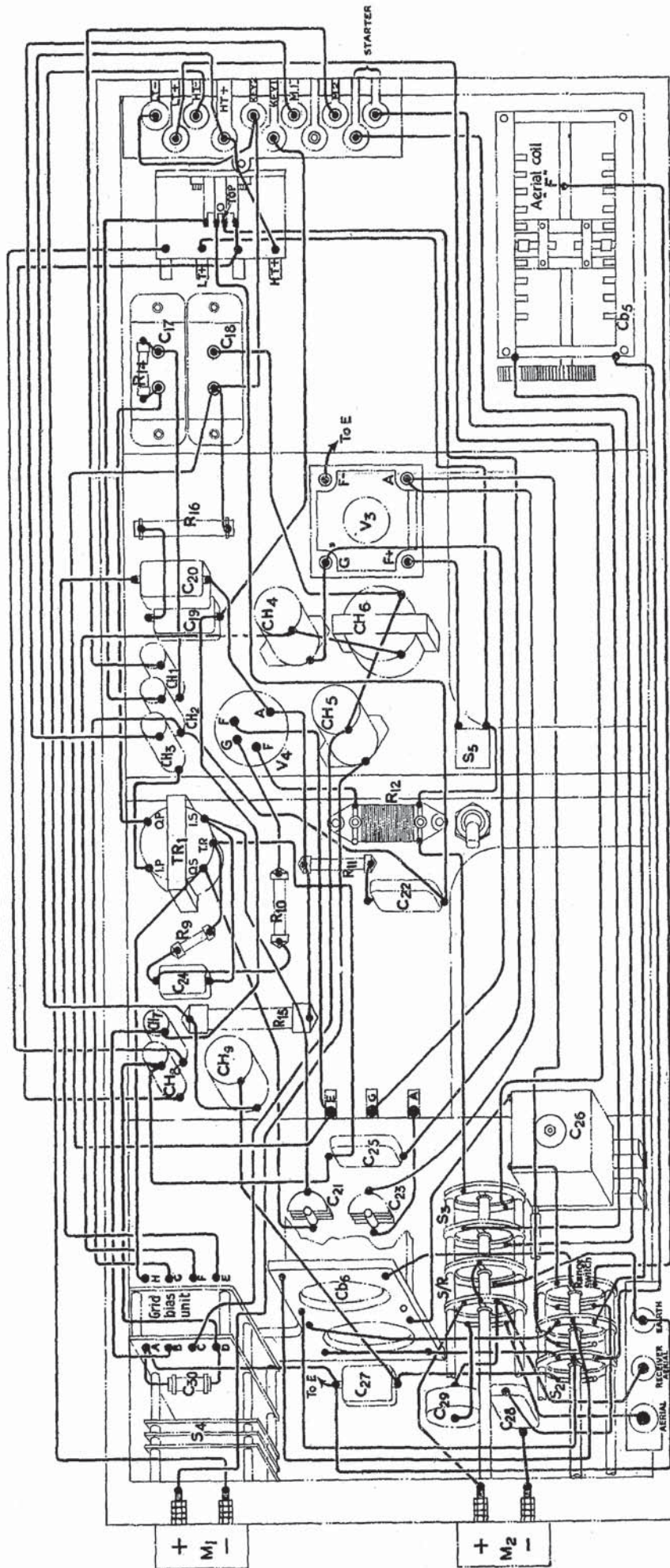
Coil units

55. Altogether, twenty-one coils are supplied with the T.1115. One of these, coil F, is integral with and forms part of the top member. A line-matching unit, coil S, is provided for output working into a low impedance line. Of the remaining coils normally only six (extra to coil F) are in the transmitter at any time. The coils are lettered from A to V (Q being duplicated as Q_1 and Q_2 whilst I and O are omitted). In the following table are set out their use and frequency coverage. To meet the frequency-changing requirements of the transmitter there must be, in use, at any time, one set of three coils from the YELLOW band and one set of three coils from the GREEN band.

COIL UNIT ARRANGEMENT

TABLE A

Band	Range	Frequency	Coil Units		
			Oscillator	Intermediate Amplifier	Aerial
YELLOW	No. 1	142- 250 kc/s	A	B	F
	No. 2	250- 500 kc/s	B	C	F
	No. 3	500-1,000 kc/s	C	D	G
	No. 4	1,000-2,000 kc/s	D	E	G
GREEN	No. 5	2.0- 4.7 Mc/s	H	J	K
	No. 6	4.7- 10.0 Mc/s	L	M	N
	No. 7	10.0- 15.0 Mc/s	P	Q_1	R
	No. 8	15.0- 20.0 Mc/s	P	Q_2	R

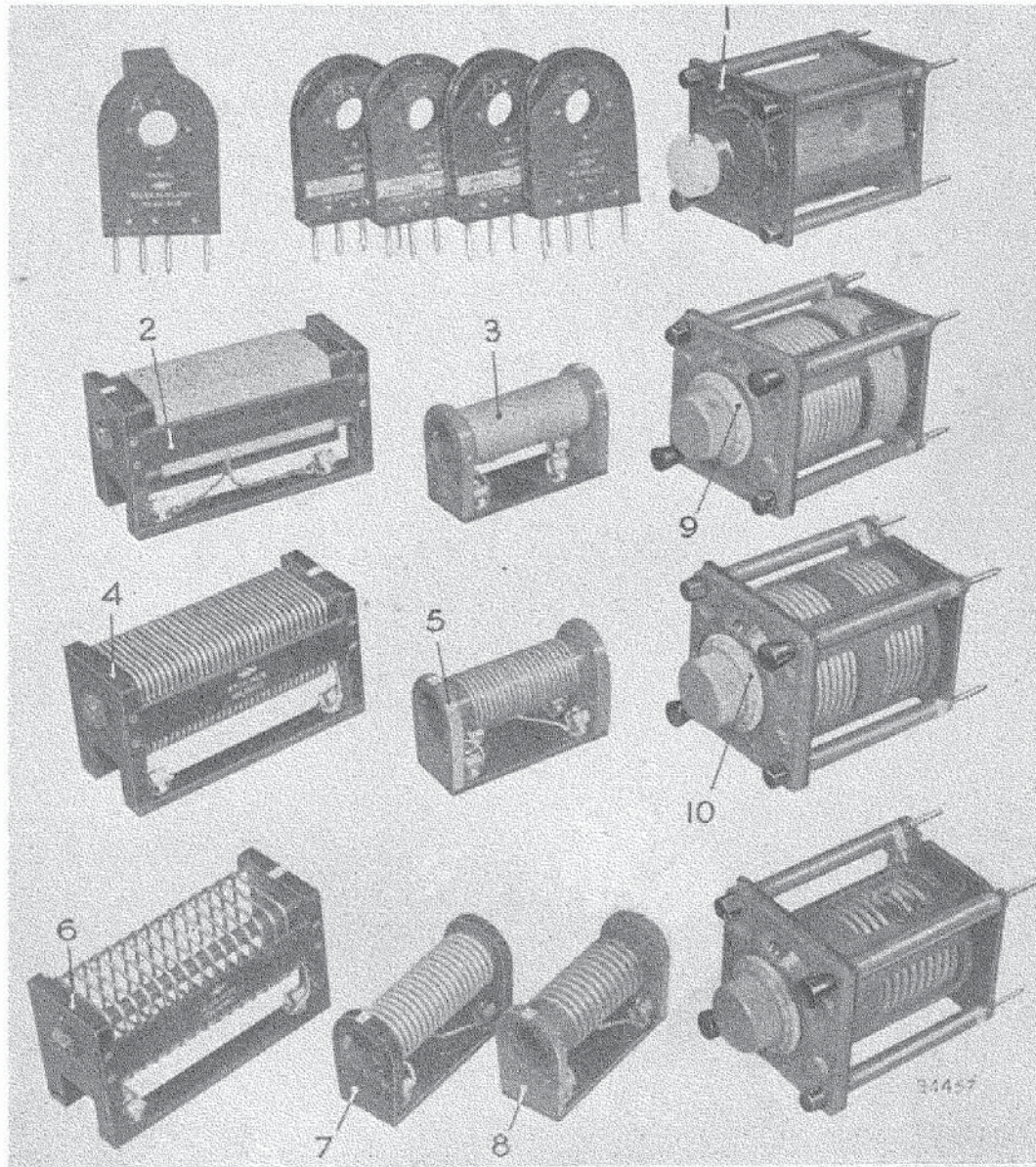


BENCH WIRING DIAGRAM, TOP MEMBER

FIG. 17

FIG. 17

56. The coils A, B, C, D and E are similar in appearance, but each has exactly four times the inductance of the succeeding one. Each coil is provided with two end connexions and two alternative H.T. positive taps. The correct H.T. positive tap is selected by the socket (1) or (2) shown in fig. 12 when the coil is inserted. As by this arrangement coils B, C and D can be used either in the Hartley oscillator circuit or in the neutralized grid circuit of the amplifier stage the total number of coils needed is reduced.



57. Coil F has been given this designation for easy reference but, actually, it is permanently built-in to the transmitter. The coarse tuning control knob ((7), fig. 1) on the front of the transmitter selects aerial and anode taps together; the fine tuning knob ((8), fig. 1) controls the variometer at the end of coil F.

58. The coil G consists of a variometer with a series-parallel switch ((2), fig. 19) and a variable, five-position, anode tap (3). The position of the rotor is indicated on the 180 degrees scale ((1), fig. 18). The switch and the taps are only accessible after withdrawing the coil from the transmitter. This coil is always carried in the transmitter and cannot be inter-changed with any other coil.

59. Referring to fig. 18 the coils H (2), J (3), L (4), M (5), N, P (6), Q1 (7) and Q2 (8) are single-layer inductances with two end connexions and an H.T. positive tap. The coil Q2 may be used over the whole range of coil P, that is 10 Mc/s to 20 Mc/s but on 10 Mc/s to 15 Mc/s the coil Q1 is more efficient.

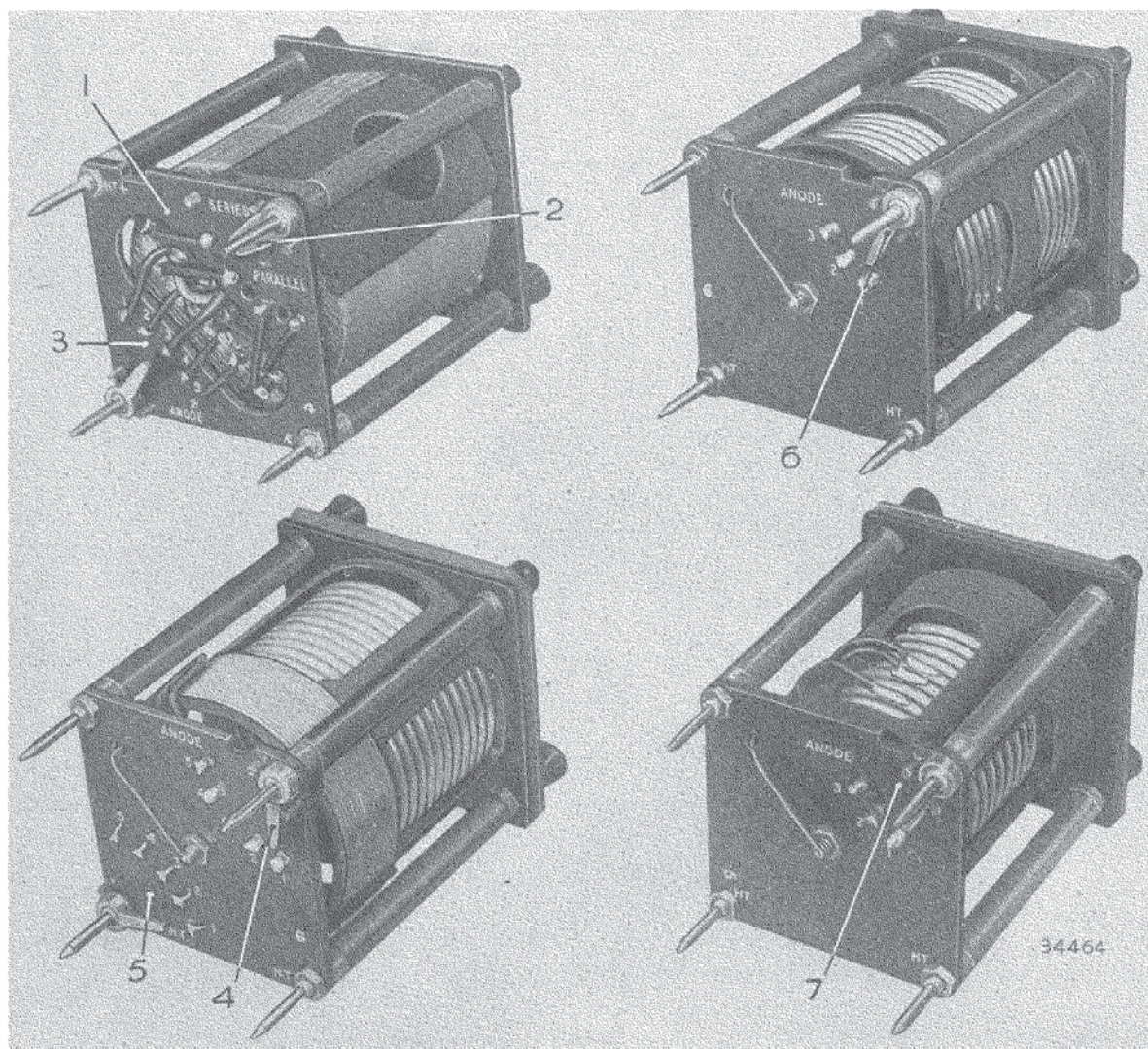


FIG. 19.—AERIAL COILS, REAR VIEWS

60. The coil K is a continuously variable inductance having the position of the slider indicated in turns and degrees (9), fig. 18). Behind the coil there are two switches five-point anode tap (4), fig. 19) and H.T. positive tap (5). The coil N is a continuously variable inductance with a three-point anode tap switch (6) at the rear of the coil. The coil R is similar and has an anode tap switch (7).

61. The coil S is a special output coil covering the band 6 Mc/s to 20 Mc/s and is used in conjunction with transmission lines. It is shown in position (1) in fig. 20 and is associated with an aerial matching unit (2), to which it is connected by a flexible electrical link. The construction and use of the coil S is described elsewhere in this publication. Briefly, the coil is matched to the line by taps controlled by a three-position switch (3) on the top right-hand corner of the unit.

62. The coil S consists essentially of a coil tuned by a condenser. The condenser is adjusted by a knob (4) through a slow-motion device and may be secured by a locking device (5). The anode tap is controlled by a switch situated at the rear of the coil unit. The receiver R.1116 is connected to the coil S by the lead (6).

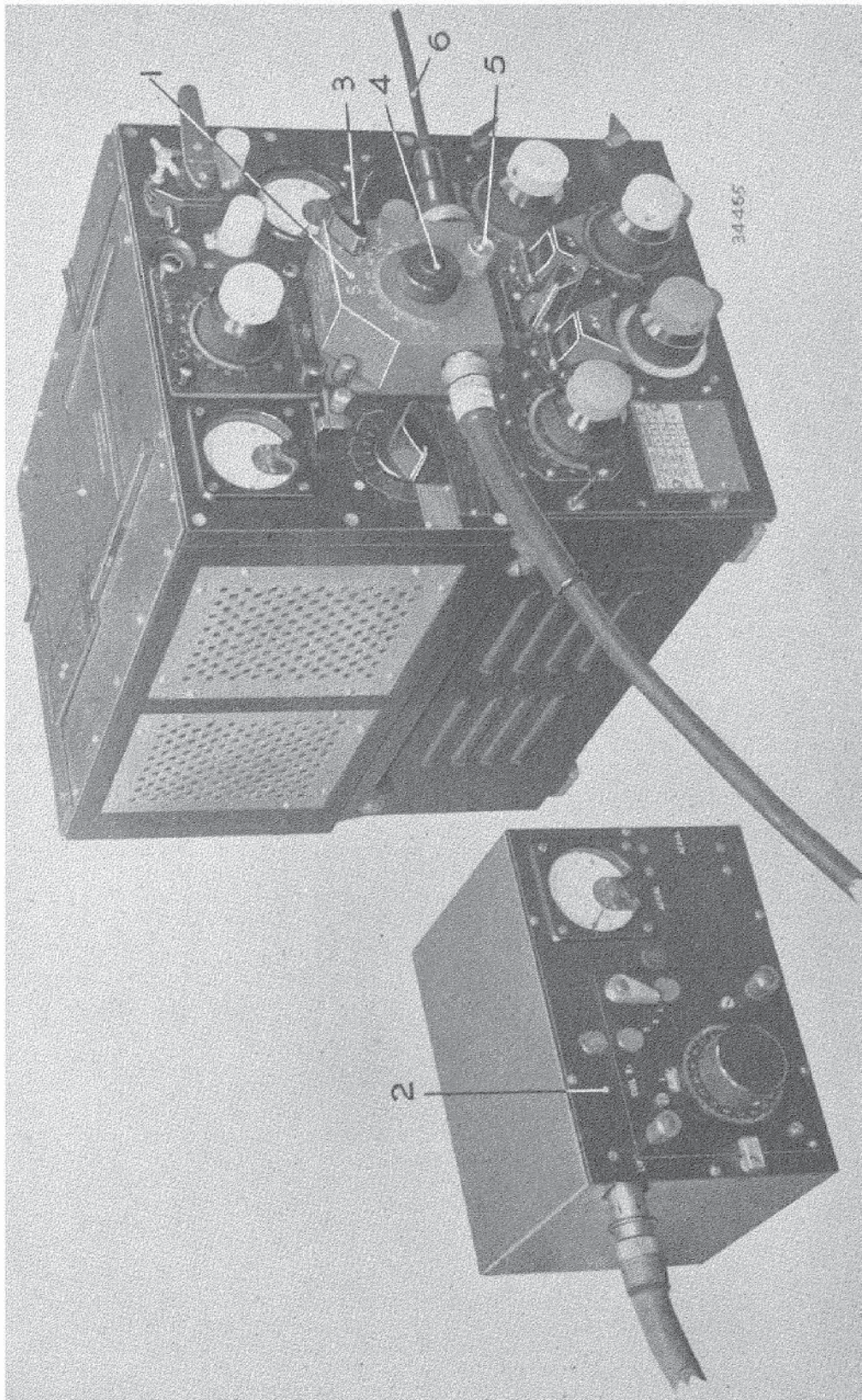


FIG. 20.—TRANSMITTER T.1115 WITH COIL S AND AERIAL MATCHING UNIT

VALVES AND POWER SUPPLY

63. Four valves are used in the transmitter, one as a master-oscillator, one as a modulator and two as the intermediate and the output-amplifier respectively. The master-oscillator and modulator are valves, type V.T.45, having an anode rating of 400 volts with a dissipation of 5 watts. In the transmitter 350 volts are used on the anode, the filament voltage being 2 volts. The intermediate amplifier is a valve type V.T.46, with 400 volts, 25 watts, anode rating and 4 volts filament. The output amplifier is a valve type V.T.47, with 6 volts filament, 600 volts anode and 20 watts dissipation.

64. The L.T. supply consists of three 2-volt A.L. accumulators wired in series. The total filament current is approximately 4.0 amps. Grid bias is automatically obtained and the microphone is energized in the associated receiver R.1116.

65. Power for the H.T. circuits of the transmitter is obtained from an 80-watt motor generator type G, which has an input of 14 volts and a 600-volt output. The type G generator has interrupter discs and is, in fact, the motor generator, type E, with the generator re-wound to 600 volts. The following motor generators, being suitable for listening-through without additional smoothing, and both containing a speech by-pass condenser of two microfarads, may also be used with the T.1115:—Type J (voltage input 12/14v.), without interrupter discs, and type H (24/28 v. input) fitted with discs. For motor generators types G and J, a starter type A is used; for type H, a starter, type C. The starters types A and C are described fully in Section 7, Chapter 11 of A.P.1095.

INSTALLATION

66. Fig. 21 is a typical installation diagram for the transmitter T.1115. A plug and socket connexion enables either a fixed or trailing aerial to be selected. Plug and socket connectors are provided between the transmitter, receiver, and motor generator.

67. Both the T.1115 and R.1116 are provided, on the under-side, with guides to enable them to be slid into position on metal runners. A typical installation arrangement provides for the transmitter to be mounted, above the receiver, on a metal structure to which the metal runners are secured by rubber mountings which afford the necessary suspension for the instruments.

68. The motor generator and starter may be located on the operator's table, and in an experimental installation (in a WALRUS aeroplane) these were placed at the extreme left-hand corner. The starter is actuated by contacts, within the switch S_3 , which close on SEND. A further 5-amp fumbler-switch may be wired to be switched off with the switch S_3 still at SEND.

69. The use of heavy duty cable is imposed in this installation to increase robustness and to minimize voltage drop, particularly in the filament circuits. The transmitter filament leads are wired with 19-amp cable.

70. The microphone circuit is connected to both the transmitter and the receiver, the microphone deriving its energizing current from the 2-volt accumulator supplying the receiver. The microphone wiring in the aeroplane is connected to the receiver through the micro-telephone socket permanently connected to the R.1116 and to the transmitter through a six-point socket and plug which joins to the terminal block (4), fig. 16) at the rear of the instrument.

OPERATION

71. It is dangerous, even for an experienced operator, to tune the T.1115 solely from the settings of the M/O circuit. Errors may easily be introduced at the frequency-doubling stage due to the difficulty of determining, by observation, which of the generated harmonics is that desired. Reference should, therefore, always be made to the operator's note-book supplied with each installation. The entries in this book, under the facsimile headings given on next page, will have been checked by wavemeter.

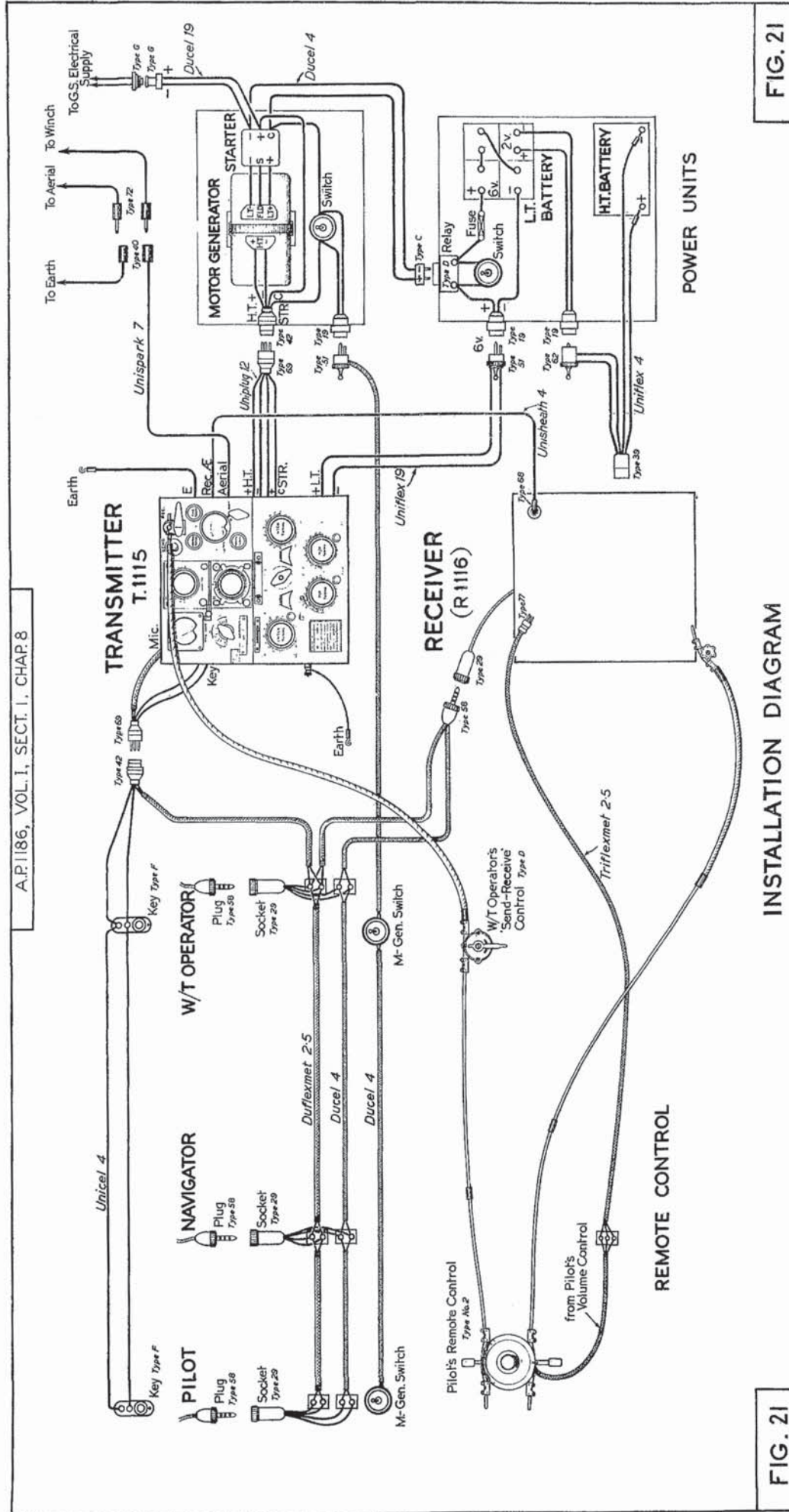


FIG. 21

INSTALLATION DIAGRAM

FIG. 21

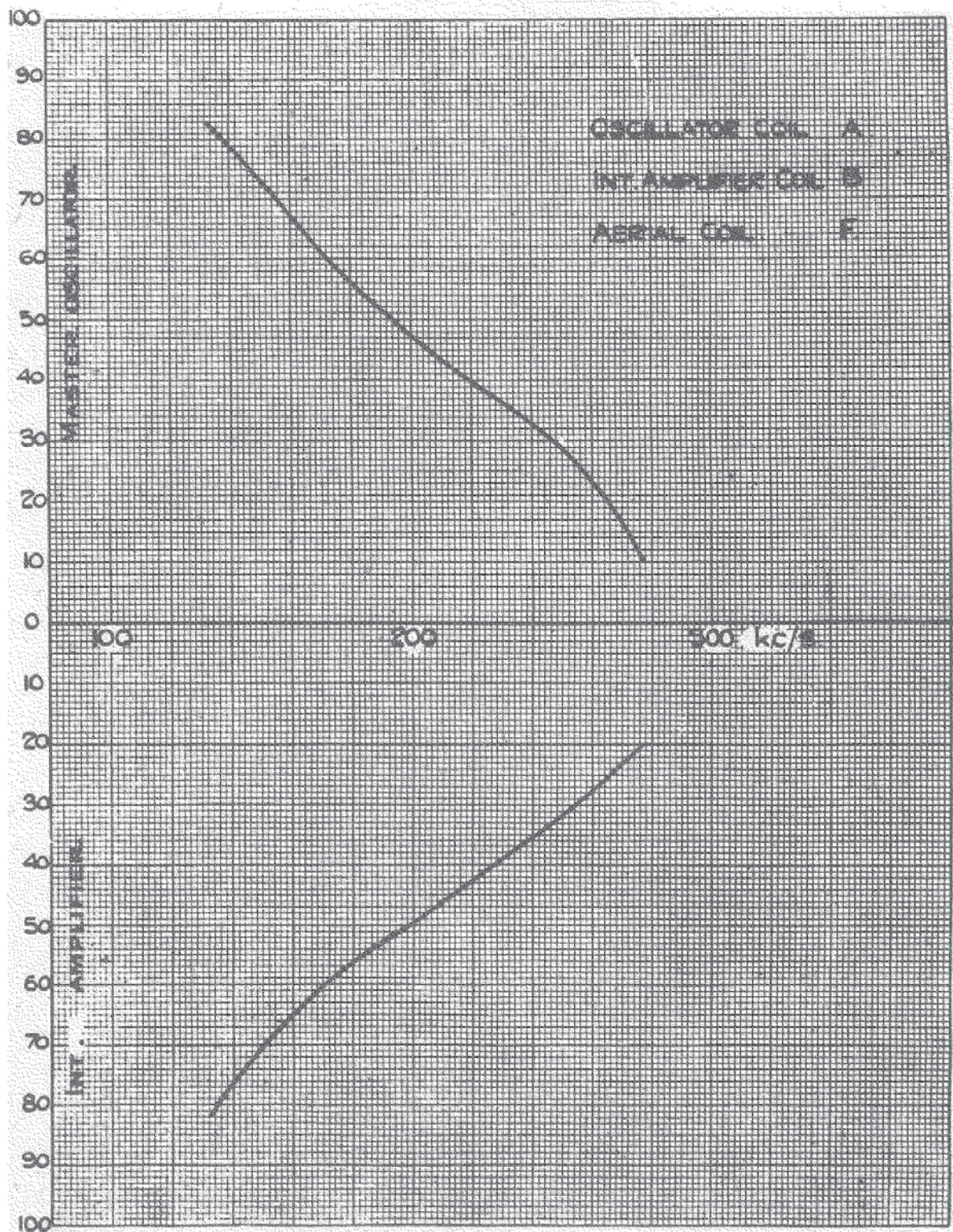
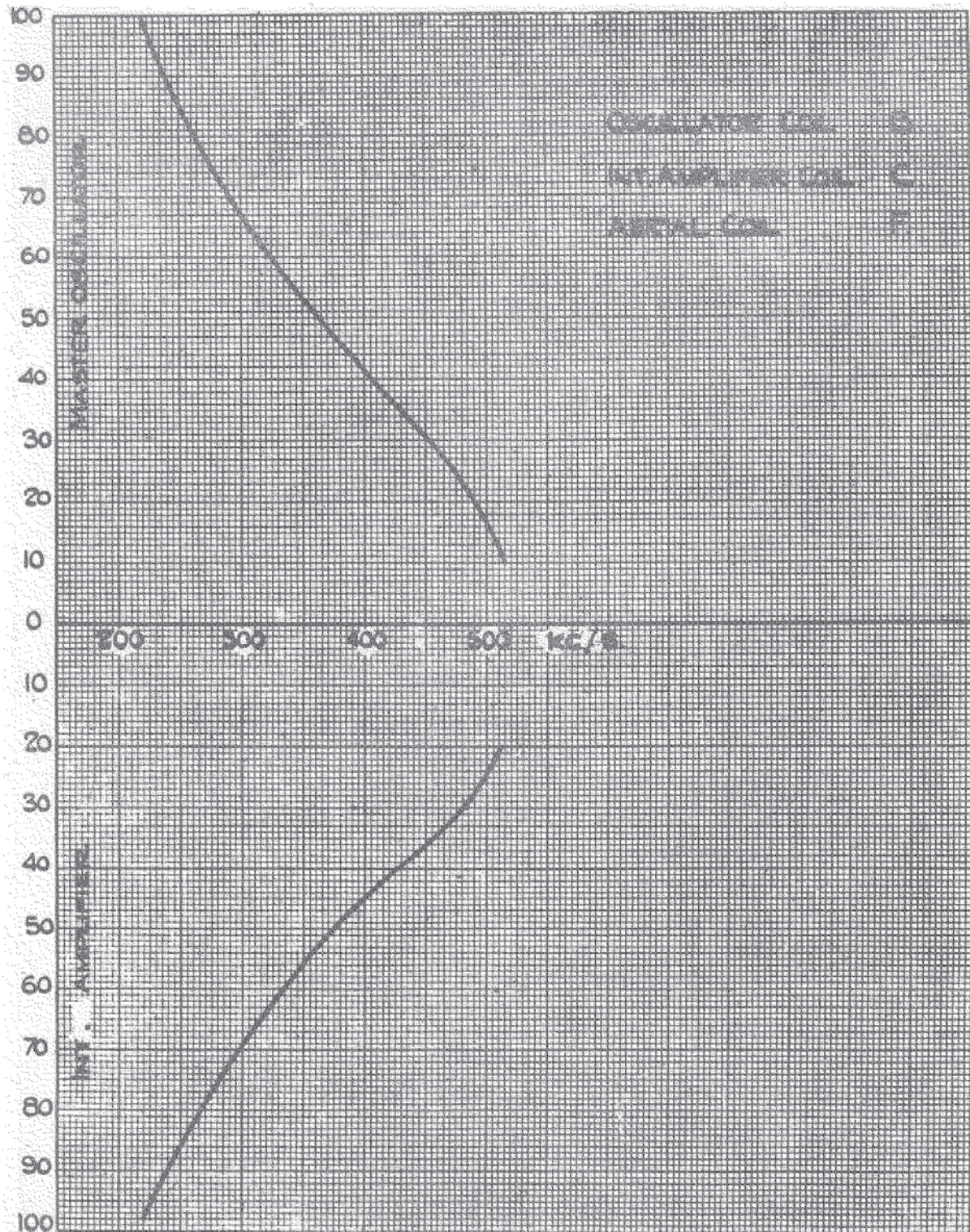


FIG.22

CALIBRATION CURVE
RANGE I (142 - 250 kc/s.)

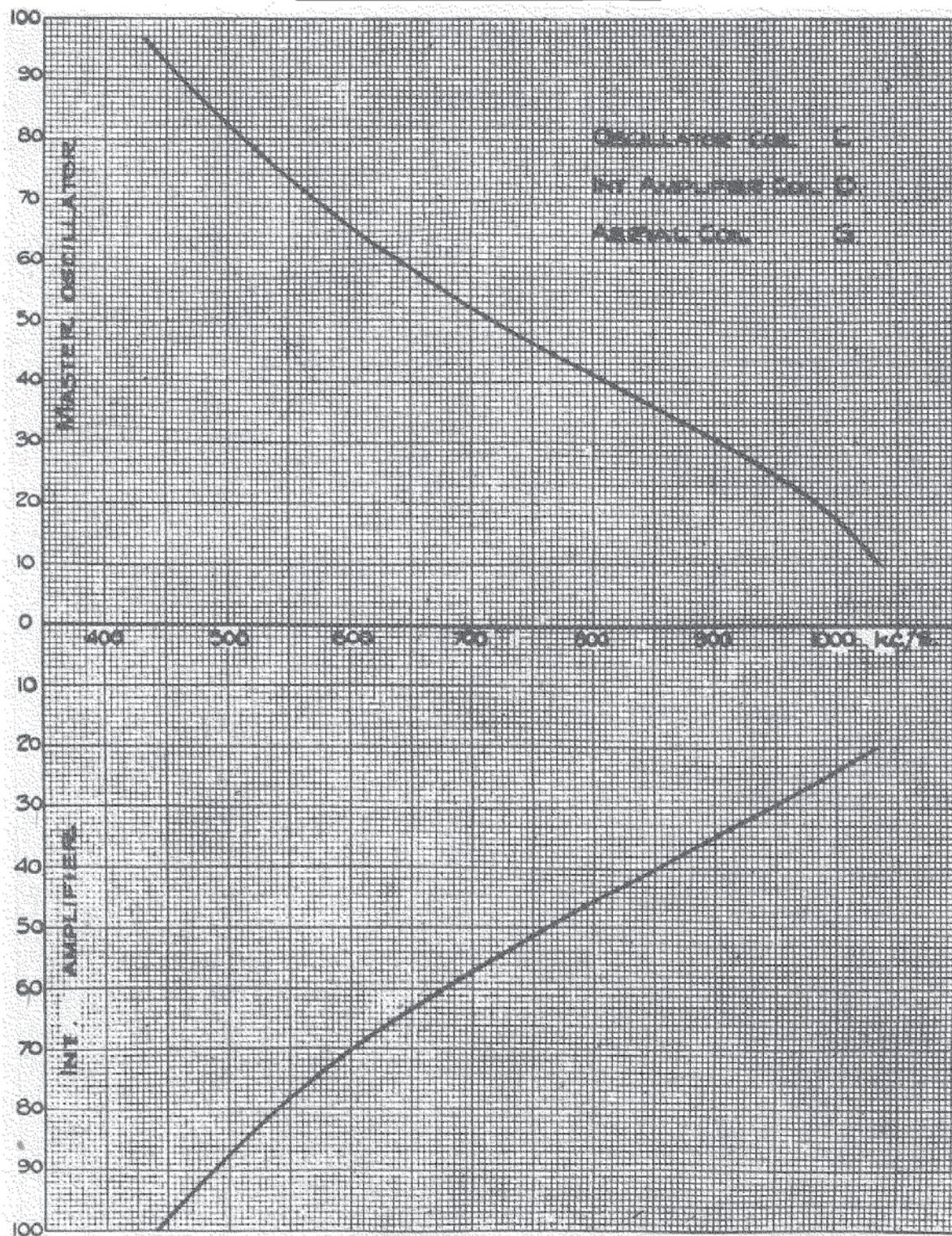
FIG.22



CALIBRATION CURVE
RANGE 2 (250 - 500 kc/s)

FIG. 23

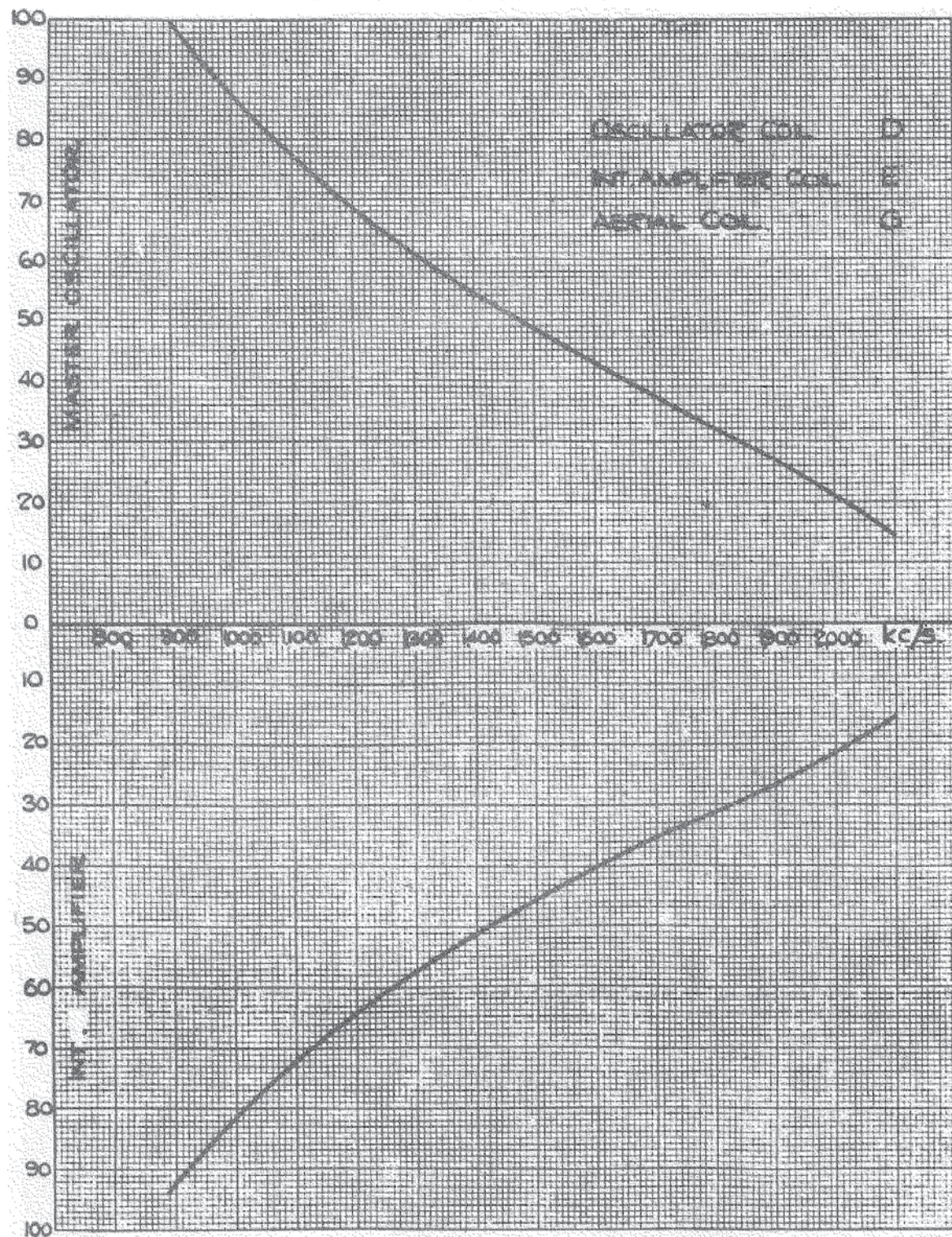
FIG. 23



CALIBRATION CURVE
RANGE 3 (500-1000kc/s)

FIG.24

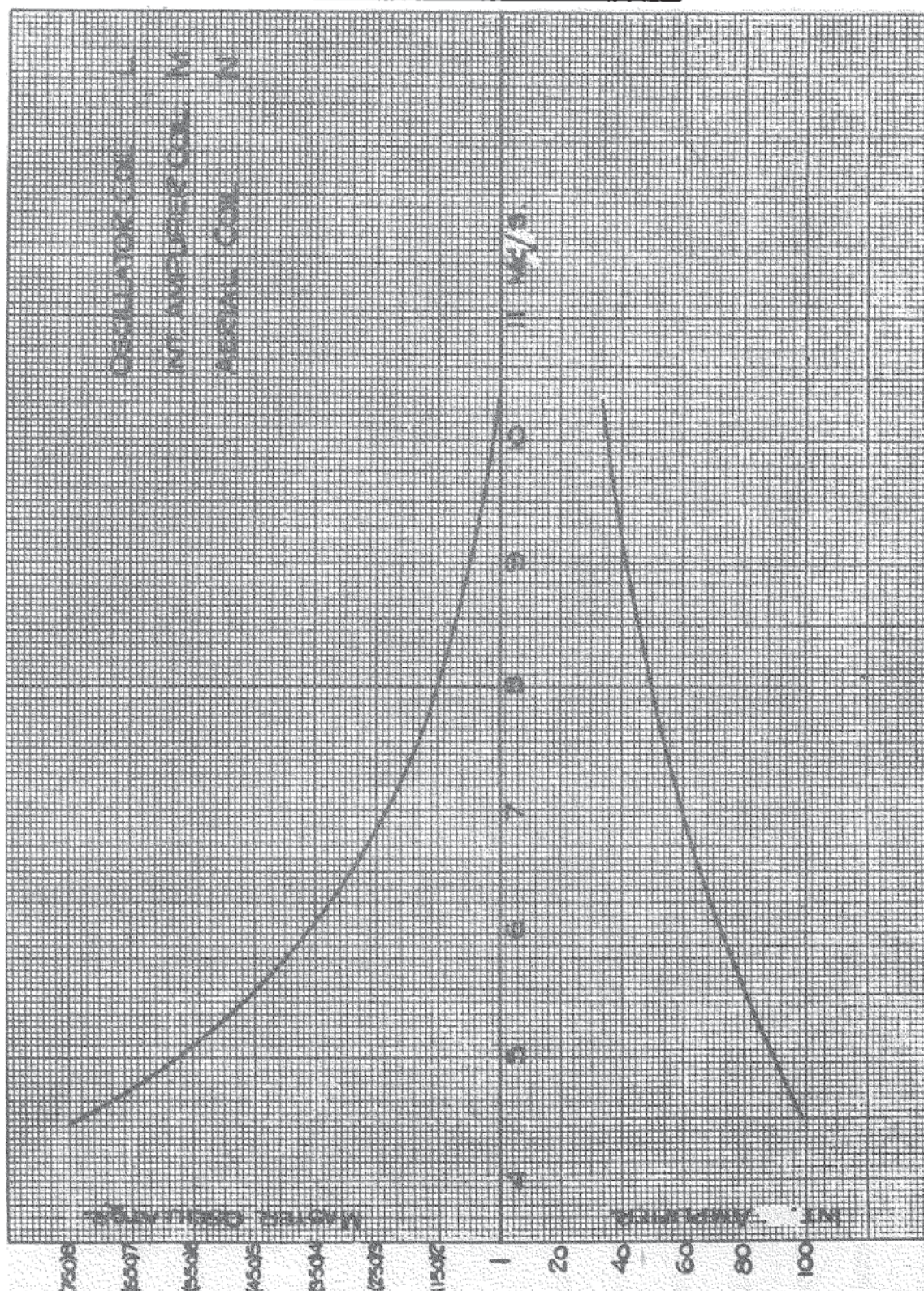
FIG.24



CALIBRATION CURVE
RANGE 4 (1-2 Mc/s.)

FIG. 25

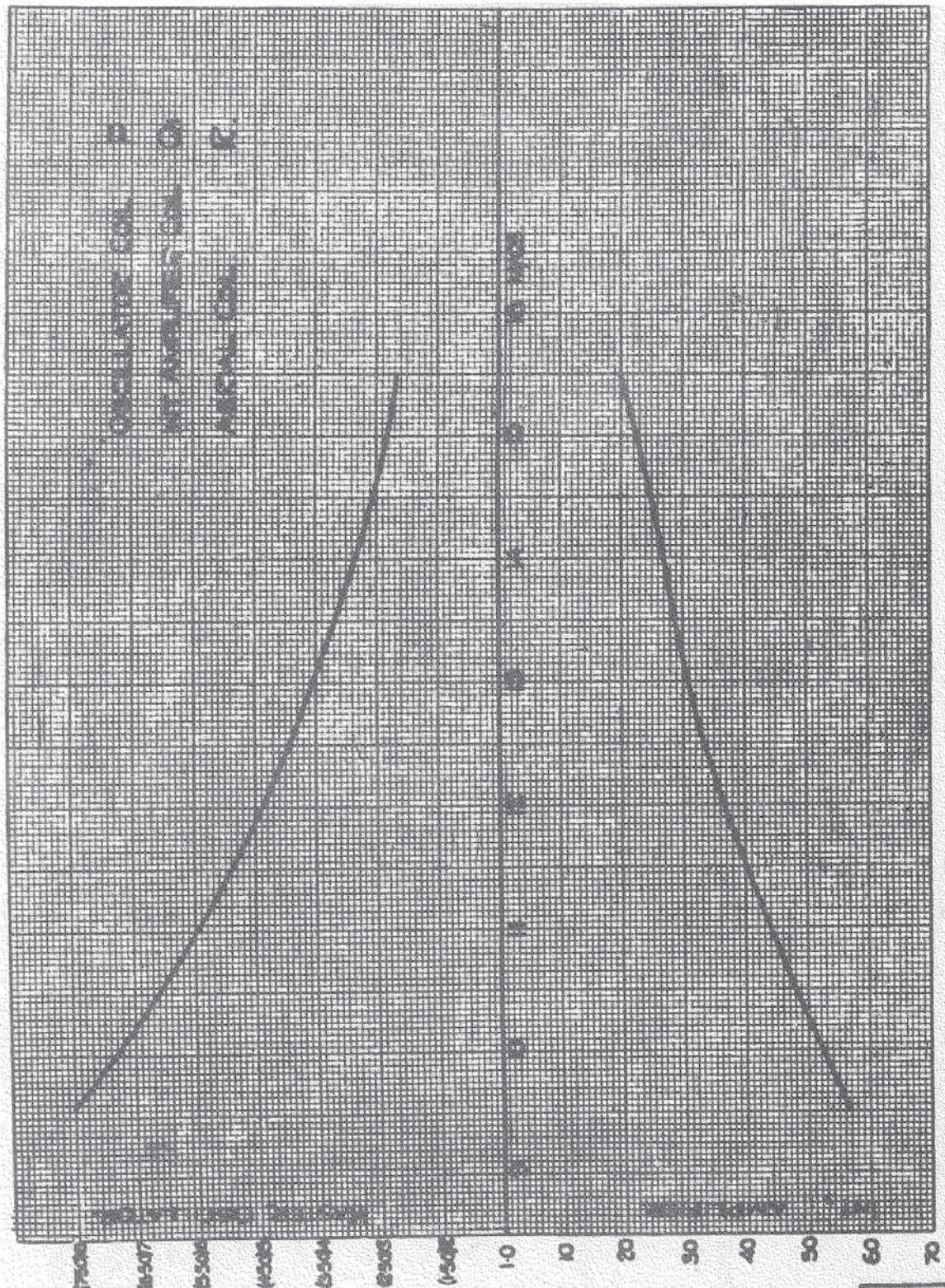
FIG. 25



CALIBRATION CURVE RANGE 6 (4.7-10.0 Mc/s)

FIG.27

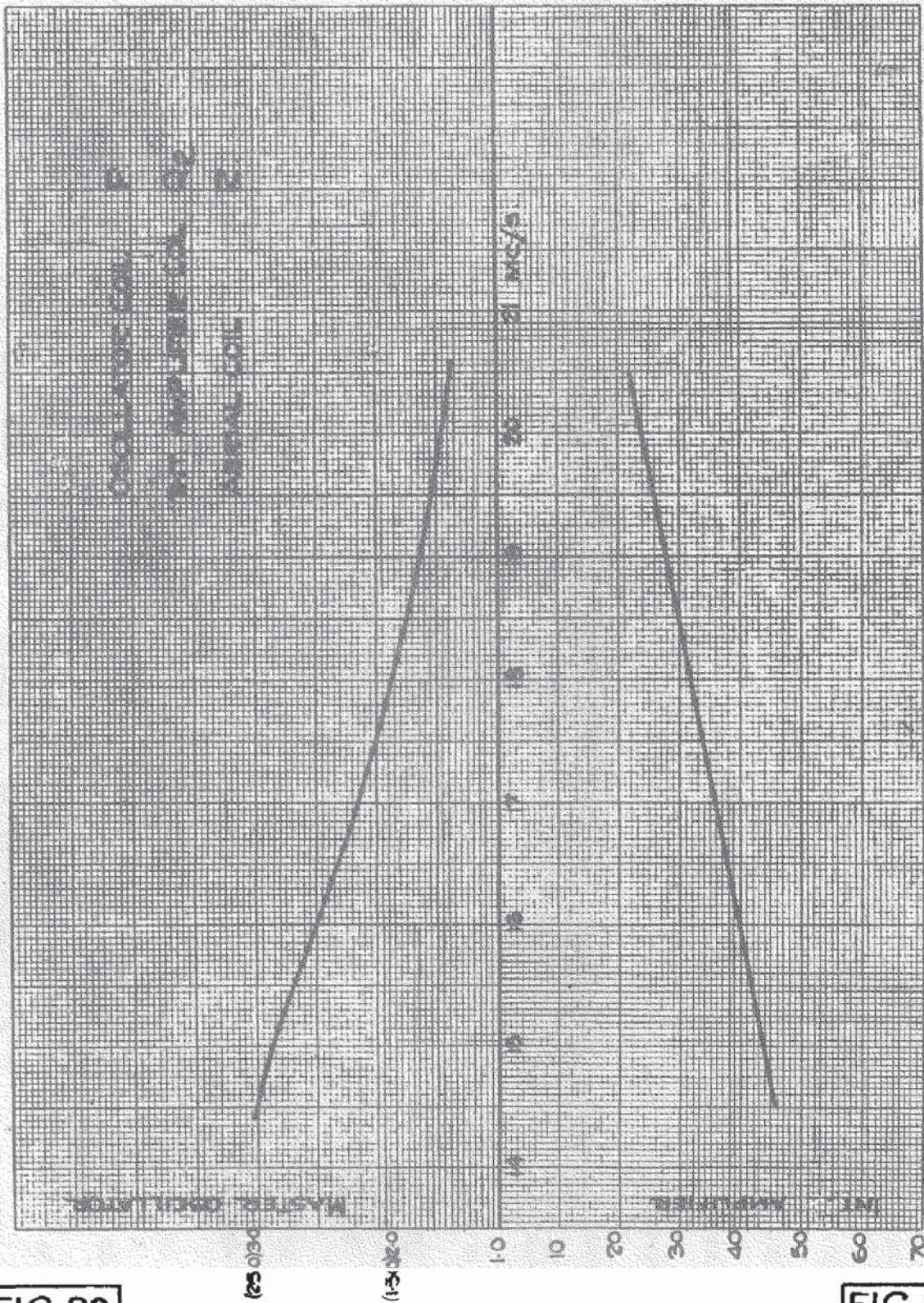
FIG.27



CALIBRATION CURVE RANGE 7 (10-15 Mc/s.)

FIG. 28

FIG. 28



CALIBRATION CURVE RANGE 8 (15-20 Mc/s.)

FIG.29

FIG.29

TABLE B
OPERATORS' NOTEBOOK

FREQUENCY SETTINGS FOR T.1115 TRANSMITTER SER. No.....															
142 kc/s-2 Mc/s RANGES (YELLOW KNOBS)															
AIRCRAFT.....			UNIT.....			No.....			DATE.....						
FREQ.	POSITION OF RANGE SWITCHES		TYPE OF AERIAL	COILS			AMP. COIL		SETTINGS				BIAS SWITCH	OUTPUT IN AMPS.	REMARKS
	1. Yel. or Grn.	2. 142-500 500-2,000 2-20 Mc/s		M.O.	Inter.	Amp.	Tap	Series or Parallel	M.O.	Inter.	Amp.				
											Coarse	Fine			

FREQUENCY SETTINGS FOR T.1115 TRANSMITTER SER. No.....																	
2-20 Mc. RANGES (GREEN KNOBS)																	
AIRCRAFT.....			UNIT.....			No.....			DATE.....								
FREQ. Mc/s	POSITION OF RANGE SWITCHES		TYPE OF AERIAL	COILS			SETTINGS						NEUT. COND. SETTING	BIAS SWITCH	OUT-PUT	RE-MARKS	
	1. Yel. or Grn.	2. 142-500 500-2,000 2-20 Mc/s		M.O.	Inter.	Amp.	M.O.		Inter.	AMP.		SERIES AE COND.					
							Coarse	Fine		Turns	De-grees	Coarse					Fine

To set up the T.1115 on the ground

72. Reference to figs. 1 and 12 will facilitate the procedure for setting up the T.1115. A suitable wavemeter, for example, the wavemeter W.1117, described elsewhere in this publication, and the calibration curves supplied with the instrument are necessary. The coils for the operational frequency are selected as specified in the Table A (para. 55). The coil F is permanently built into the transmitter. For special purposes the following additional coils may be used:—the coil S covering the band 6 Mc/s to 20 Mc/s and coils T, U and V covering the band 3 Mc/s to 6.5 Mc/s. The anode tap and switch on the aerial coils should be set before inserting them in position. For procedure in adjusting coil taps and for revised setting-up procedure *see* ADDENDUM, paras. 105 to 111.

73. The bottom member should be removed from the instrument, by releasing the four wing nuts (1), and the appropriate coils inserted into the positions and locked, as indicated on fig. 12. The YELLOW range M/O coil is inserted in the position marked (1), the YELLOW range intermediate-amplifier coil in position (2), the GREEN range M/O coil in position (3) and the corresponding intermediate-amplifier coil in position (4). The aerial coil will normally be carried in position (6), fig. 1) on the front panel. The GREEN range aerial coil should be inserted in the position indicated (5), fig. 1).

74. The valves should then be inserted into their appropriate sockets. The M/O requires a type V.T.45 valve and is placed in the socket (9) shown on fig. 12. The intermediate amplifier is a valve type V.T.46 (10), fig. 12), the amplifier a valve type V.T.47 and the modulator a V.T.45. These valves can be seen in position in fig. 16. The appropriate aerial should be connected.

75. Typical calibration curves for the eight ranges are given in figs. 22 to 29. Having obtained the approximate settings for the M/O and intermediate amplifier tuning from the calibration curves, the appropriate dials should be set to these readings. The GREEN dials C_{15} and C_8 are for the higher frequencies, the YELLOW dials being C_{12} and C_5 .

76. The two range switches S_1 and S_2 are now turned to the appropriate band, and the bias switch S_4 is set to C.W.1. Should crystal control be required, the crystal holder is inserted in position (3), fig. 11) so that the indicator (2), fig. 1) reads X-TAL/OSC. Switch ON the transmitter by S_3 .

77. The M/O tuning should now be adjusted, using the condenser C_{15} for the GREEN range and C_{12} for the YELLOW range, until the correct frequency is obtained as indicated on the wavemeter located near the aerial lead. The intermediate tuning condenser, C_6 for GREEN and C_5 for YELLOW, should now be utilized very carefully to give maximum input current as read on the input meter M_1 . The approximate tuning position of the aerial circuit is obtained by the controls (7) and (8) shown on fig. 1, when the coil F is used, and by the controls (5) and (9) when the coils J, N or R are used.

78. Turn the bias switch S_4 to the position C.W.2 or C.W.3 so that the input as read on M_1 is as large as possible, but not exceeding 133mA. Next, tune the aerial circuit to give maximum output on the meter M_2 .

79. The neutralization must now be checked. The method of neutralizing is to switch off the amplifier filaments by means of the switch S_5 . Access to S_5 can be obtained by sliding back the cover (10) on the top of the transmitter. Tune the neutralizing condenser C_{33} (fig. 15) which will be found adjoining the switch S_5 , and has an insulated knurled spindle, until a minimum reading is obtained on the wavemeter located near the aerial lead. Switch on the amplifier by S_5 and the instrument should now be neutralized. It may be necessary slightly to retune the aerial circuit for minimum input.

80. Having thus lined up the transmitter for one particular frequency, the figures should be recorded in the operator's notebook. This process should be repeated for any other frequency settings. It should be noted that the T.1115 can be set up with one lower (YELLOW) frequency and one higher (GREEN) frequency pre-set and clamped.

To set up frequencies in flight.

81. All relevant information with regard to coils and settings necessary to set up the transmitter in flight will be found in the operator's notebook. The coils should be selected for the particular frequency and plugged into their correct positions. The tuning dials should be turned to the specified settings, switches adjusted to the positions indicated and the transmitter switched ON. Next, the aerial circuit should be tuned, using the appropriate controls and, finally, the output meter reading on M_2 should approximate to that recorded in the notebook. The neutralisation, and checking thereof is essentially a bench operation and no attempt should be made to adjust the setting of the condenser C_{23} in the aeroplane.

Tuning procedure, R/T and T.T.

82. When tuning for R/T set up the transmitter to give maximum output on C.W. Adjust the bias control switch to an R/T position which gives approximately half the C.W. output. If a higher aerial current than this is chosen the depth of modulation will be reduced with a corresponding reduction in range. For T.T. the switch S_4 should be finally set to the position which bears the same number as the R/T position. In place of "R/T.4." use "T.T.3".

Aerials

83. All frequencies on the YELLOW band can be worked on the standard 200 ft. trailing aerial. All frequencies on the GREEN band, up to about 7 Mc/s can be worked on an ordinary fixed aerial of about 100 $\mu\mu\text{F}$. Frequencies above 7 Mc/s can best be worked either by shortening the fixed aerial or by using transmission lines.

84. Frequencies from about 600 kc/s to about 7 Mc/s can all be worked on a 100 $\mu\mu\text{F}$ fixed aerial without loss of output. Frequencies of from 142 kc/s to 600 kc/s can be worked on the same aerial with some loss of efficiency.

85. If only a very short fixed aerial (say from 60 to 70 $\mu\mu\text{F}$) is fitted, it will not be suitable for frequencies below about 2,000 kc/s. From 142 kc/s to 500 kc/s the standard trailing aerial should be used; from 500 kc/s to 2000 kc/s about 100 feet of trailing aerial is sufficient.

PRECAUTIONS AND MAINTENANCE

86. Under normal conditions, the only spares which will be carried are valves, coils and dial lamps. In view of the intricate parts involved in the transmitter proper it is recommended that no real servicing should be attempted apart from the insertion of the components mentioned. The receiver R.1116 should be switched on before any attempt is made to tune the transmitter.

87. The input to this transmitter should never be in excess of 133mA as shown on M_1 . This should be particularly noted during the tuning process. Accurate setting of the M/O dial is very

important. Care should be taken, when tuning the intermediate amplifier, that the final setting is close to the setting specified in the operator's notebook. If this is not done there is a danger that the wrong harmonic will be chosen.

88. It is important that the transmitter H.T. voltage should be not less than 600 volts. The motor generator, type G, is rated to give 80 watts at 600 volts when the motor side is connected to the aeroplane electrical supply in which the battery is on charge from the engine-driven generator. The full output from the type G generator, and therefore from the transmitter, will not be obtained when the aeroplane engines are not running. In addition to consequent loss of power there may be some reduction in speech quality when radiating R/T with less than 600 volts H.T.

89. No interference from the aeroplane engine should be experienced and interference from the engine-driven electrical generator should be negligible. To check whether any arises, the charging switch should be put to OFF, thus breaking the field circuit of the generator. Interference from the M/G whilst in "listening-through" indicates that the commutators and brush gear of the machine require attention and cleaning. These should be periodically inspected and the commutators cleaned when necessary.

90. To guard against corrosion it is advisable to smear the installation runners upon which the instruments slide, with grease. The rubber mountings should be frequently inspected.

91. It is essential that the L.T. accumulators are well charged and in good condition. Should the voltage fall below 5 volts the transmitter will not function.

92. Ensure that the switch S_3 is at OFF before leaving the transmitter, otherwise the L.T. may be left on. Use short L.T. leads and a good short earth connexion is very desirable.

93. Always screw the oscillator tray securely into its cast case and lock all coils in position.

Fault finding

94. The following procedure will give some guide to fault finding:—Switch off the output valve filament by S_5 and remove the valves V_1 and V_4 , leaving V_3 (the oscillator valve) in position. Plug in the coils, setting the band switches and the bias switch to the usual tuning positions.

95. Put the switch S_3 to SEND. The input should be about 6 to 10mA. An input of about 20mA shows that the oscillator stage is not oscillating.

96. Insert the pentode V_1 . Set the intermediate amplifier tuning from the notebook, and switch ON. The input should read about 40mA. When the intermediate circuit is brought into tune the input should fall by about 10mA. Should this not occur suspect a failure in the intermediate circuit.

97. Switch on the output amplifier by S_5 , mistune the aerial circuit and switch ON. When the intermediate circuit is brought into tune the input should rise. If no rise is observed suspect a failure of the output valve anode circuit.

98. Should the tests in paras. 94–97 indicate no fault, but aerial current cannot be obtained, suspect either the aerial-and-earth system or the aerial circuit of the transmitter. A test on artificial aerial will eliminate the former.

99. As a test of the modulator stage, insert V_4 and see that the expected rise of about 15 per cent. to 20 per cent. in aerial current occurs on changing from R/T to T.T. with the morse key depressed. For this test the correct bias tap must be used.

ADDENDUM I

NOTES ON OPERATION

Tuning procedure C.W.

100. The following notes should be considered as extending and, where necessary, correcting the information given in paras. 72 to 80. Withdraw the M/O and intermediate coils and clamp securely in position. The arrangement and combination of plug-in coils is shown in para. 55 and this is duplicated in the table situated on the front panel (bottom left-hand corner of fig. 1). Replace the chassis and screw securely by the four wing nuts (1, fig. 1). Plug in the requisite aerial coil (5 or 6, fig. 1). The fact that the T.1115 is actually *two* transmitters with duplicated tuning controls should be appreciated.

101. Set the bias control switch S_4 as indicated below:—

20 Mc/s to 15 Mc/s	...	...	...	...	R/T4
15 Mc/s to 10 Mc/s	...	...	...	...	R/T3
10 Mc/s to 4.7 Mc/s	...	...	...	...	R/T2
4.7 Mc/s to 2.0 Mc/s	...	...	...	...	R/T1
Frequencies below 2.0 Mc/s	...	...	...	...	R/T1

102. By reference to the calibration curves, figs. 22 to 29, adjust the M/O and intermediate amplifier tuning controls (*see* para. 77) to the desired frequency. The calibration curves are for guidance only and the frequency should be finally checked by a wavemeter W.1117.

103. Put the S/R switch S_3 to SEND and carefully adjust the appropriate intermediate amplifier tuning control for maximum input as read on M_1 . This current should be approximately 90 mA and, assuming 600 volts H.T. input, this is the reading which will be given by the correct tuning bias (para. 101). The figure of 90 mA should not be exceeded when tuning. Maximum input should occur in close proximity to the position found on the calibration curves.

104. Adjust the aerial coil tuning (para. 77) for maximum output, as read on M_2 , against minimum input (M_1). Next, adjust the bias control switch S_4 to a C.W. position which gives approximately 80 watts total H.T. input; that is, 135 mA on M_1 . Check the frequency by the wavemeter W.1117 and lock the M/O and intermediate amplifier controls by the locking devices one of which is indicated at (3, fig. 1).

Coils

105. The positions of the adjustable anode taps for coils R and N are shown at (7 and 6, fig. 19). Should there be any doubt as to which tap should be used commence the tuning procedure with the high tap 3. Should input (para. 104) be below 80 watts select a lower tap and retune.

106. When adjusting coil K regard the 5 anode taps (4, fig. 19) and the 5 H.T. positive taps (5) as coarse tuning. The variable adjustment (9, fig. 18) moves between the taps. It is essential that the H.T. positive and anode taps should correspond numerically, that is, if the H.T. is at tap 2 the anode tap should also be at tap 2. The highest tap gives the lowest frequency (*see* inset to fig. 2).

107. The adjustment of the position of the anode tap (3, fig. 19) of coil G is made as indicated for coils R and N. The series-parallel switch (2) is set as follows:—

PARALLEL — approximately 2.0 Mc/s to 1 Mc/s.

SERIES — approximately 1,000 kc/s to 500 kc/s, depending upon the constants of the aerial system.

It has been found, in practice, that when using the T.1115 on frequencies between, approximately, 4.2 Mc/s and 12 Mc/s, coil G, when plugged into position, may absorb energy from the H.F. coil in use at the time. This absorption is indicated by a rise in input mA on M_1 with a corresponding decrease in aerial current (M_2). When this trouble is experienced reference should be made to the leaflet A.P.1186, A.149—W. The coil F is described in para. 57 and illustrated in fig. 18.

108. The series aerial condenser C_{29} (*see* paras. 19, 43 and 50) is normally short-circuited, that is, its control is taken beyond the clockwise maximum and actuates the switch S_8 . Should there be any difficulty in obtaining resonance when tuning the higher frequencies of, for instance, over 6 Mc/s the condenser should be introduced. There will be an optimum setting of this condenser for individual frequencies and this can be found by the adjustment of it in conjunction with the output coil. As the condenser C_{29} is turned counter-clockwise more turns will be required on the coil.

Neutralizing

109. Referring to para. 79, it should be understood that transmitters are despatched from the makers correctly adjusted and neutralizing should not be necessary except in the frequency range of 20 Mc/s to 15 Mc/s. The correct procedure for neutralizing is to set up the transmitter as indicated in paras. 100 to 104, switch off the H.T. by S_2 , switch off the amplifier valve filaments by S_5 , adjust the neutralizing condenser C_{23} (8, fig. 15) and then switch on the amplifier valve filaments. When the H.T. is switched ON the maximum output and minimum input condition should be obtained.

Setting-up for crystal control

110. Referring to para. 76, the following is the procedure for setting-up the T.1115 with crystal control. Having inserted the appropriate crystal, the fundamental frequency of which should be half the required output frequency, by reference to the calibration curves adjust the C/O tuning to a frequency slightly lower than the output frequency. Bias back by S_4 and slowly reduce C_{15} until a slight fall of input is observed, then tune the transmitter in the normal manner. The control of C_{15} should then be set back on the H.F. side to give approximately 10 per cent fall in output current (M_2) from the maximum in order to ensure good keying.

111. Should it be desired to use crystal units which differ from the standard size, certain modifications to the existing crystal holder, in accordance with the procedure set out in the A.P.1186, Vol. II leaflet dealing with this modification must be made.

APPENDIX 1

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this transmitter, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10A/10380	Transmitter, type T.1115			
	Consisting of:—			
10D/10381	Amplifier unit	1		For detail, see below
10D/10382	Case, master-oscillator unit	1		
10A/10383	Master-oscillator unit	1		For detail see below
10D/10381	Amplifier unit			
	Principal components			
10A/8038	Ammeter, thermo 0-2.5, Type A	1	M ₂	
	Block, terminal			
10H/10490	Three-way	1		
10H/10491	Eleven-way	1		
10H/10489	Brackets, type D	1		
	Choke, H/F			
10C/8484	Type 19	5	Ch ₁ , Ch ₂ , Ch ₃ , Ch ₇	Ch ₈
10C/10504	Type 41	1	Ch ₄	
10C/10505	Type 42	2	Ch ₅ , Ch ₉	
10C/7912	Choke, L/F, type G	1	Ch ₃	
10D/10506	Coil, aerial F	1		142-500 ks/c
	Condenser			
10C/9178	Type 279	1	C ₂₄	0.0003 μ F
10C/10507	Type 374	1	C ₂₃	10 μ F var.
10C/10508	Type 375	1	C ₂₁	40 μ F
10C/10509	Type 376	2	C ₁₇ , C ₂₈	2.0 μ F
10C/10510	Type 377	1	C ₃₀	0.0004 μ F
10C/10511	Type 378	4	C ₂₀ , C ₂₅ , C ₂₇ , C ₂₈	0.01 μ F
10C/10512	Type 379	1	C ₂₂	0.001 μ F
10C/10513	Type 380	1	C ₂₆	250 μ F var.
10C/10391	Type 401	1	C ₁₉	0.002 μ F
	Type	1	C ₂₉	0.0004 μ F
10D/10403	Covers, top	1		
10A/10492	Cradles, valve	1		
10D/10514	Grid-bias unit, type 6	1	R ₁₇	Fitted with:— Resistance, 10C/11699, type 527 50 ohms. 10C/11700, type 528, 150 ohms. 10C/11701, type 529, 250 ohms. 10C/11702, type 530, 100 ohms. 10C/11703, type 531, 400 ohms. 10C/11704, type 532, 500 ohms. 10C/11705, type 533, 600 ohms.
10A/10493	Guides, valve	1		
10A/10515	Heads, remote control	1		
	Holders			
10H/10397	Resistance, 1 watt	2		
10A/10398	Resistance, 3 watts	1		
10H/2412	Valve, V.T. 13	1		For valve, V.T. 47
10H/10516	Valve, type 7	1		For valve, V.T. 45
10A/10517	Milliammeter, 0-200 mA	1	M ₁	
	Moulding			
10D/10481	Frame No. 1	1		
10D/10482	Frame No. 2	1		
10D/10483	Frame No. 3	1		
10D/10484	Frame No. 4	1		
10D/10485	Frame No. 5	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter, type T.1115—(contd.)			
	Amplifier unit—(contd.)			
	Principal components—(contd.)			
10D/10486	Frame No. 6	1		
10D/10487	Frame No. 7	1		
10D/10488	Frame No. 8	1		
	Resistance			
10C/7267	Type 29	1	R ₁₁	250,000 ohms
10C/7602	Type 72	1	R ₁₀	500,000 ohms
10C/7954	Type 101	1	R ₁₄	1,000 ohms
10C/8017	Type 109	1	R ₉	2 megohms
10C/10139	Type 367	1	R ₁₅	20,000 ohms
10C/10416	Type 386	1	R ₁₂	8.5 ohms
10C/208	Type 676	1	R ₁₃	200 ohms
10A/9879	Spring, contact	5		For coil contacts
	Switch			
10F/10451	Type 140	1	S ₃	
10F/10338	Type 152	1	S ₅	
10A/10518	Transformer, microphone, type 54	1	T ₁	
10A/10383	Master-oscillator unit			
	Principal components			
	Bases			
10A/10384	Master-oscillator coil mounting	1		
10A/10438	Resistance and condenser unit	1		
	Condenser			
10A/10385	Type 395	1	C ₈	250 $\mu\mu$ F var.
10A/10386	Type 396	1	C ₅	250 $\mu\mu$ F var.
10A/10387	Type 397	1	C ₃	52 $\mu\mu$ F
10A/10388	Type 398	1	C ₁₀	32 $\mu\mu$ F
10A/10389	Type 399	1	C ₁₅	250 $\mu\mu$ F var. Fitted with 10A/10410, knob
10A/10390	Type 400	1	C ₁₂	250 $\mu\mu$ F var. Fitted with 10A/10409, knob
10A/10391	Type 401	2	C ₄ , C ₉	0.002 μ F
10A/10392	Type 402	1	C ₁₆	0.0002 μ F
10A/10393	Type 403	4	C ₁ , C ₆ , C ₁₁ , C ₂	0.01 μ F
10A/10394	Type 404	1	C ₁₃	10 $\mu\mu$ F
10A/10395	Type 405	1	C ₇	30 $\mu\mu$ F
	Holder			
10A/10396	Crystal	1		For X ₁
10A/10397	Resistance, 1 watt	1		
10A/10398	Resistance, 3 watts	4		
10A/10399	Valve, type V	1		For valve, V.T. 46
10A/10400	Valve, type W	1		For valve, V.T. 45
	Knobs, slow motion			
10A/10525	Green	1		Inter-tuning
10A/10410	Green	1		Insulated (see item 10A/10389)
10A/10411	Yellow	1		Inter-tuning
10A/10409	Yellow	1		M/O
10A/10524	Lampholder, M.E.E.	1		
10A/10412	Mounting, terminal inter- mediate panel	1		
	Resistance			
10A/7603	Type 73	1	R ₄	200,000 ohms
10A/10413	Type 383	2	R ₂ , R ₃	25,000 ohms
10A/10414	Type 384	1	R ₇	30,000 ohms
10A/10415	Type 385	1	R ₁	1,000 ohms
10A/10416	Type 386	1	R ₆	8.5 ohms
10A/10417	Type 387	1	R ₈	0.9 ohms
	Type	1	R ₅	50,000 ohms
10A/9879	Spring, contact	9		
10A/10418	Switch, type 142	1	S ₁	
	Accessories			
5A/1387	Accumulator, lead acid 2v. 20 A.H., type B	3		
10D/28	Book, operator	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter, type T.1115—(contd.)			
	Accessories—(contd.)			
	Principal components—(contd.)			
	Case			
10A/10419	Transit	1		For coils A to S
10D/27	Transit	1		For coils T, U, and V
10D/130	Transit	1		For coil S
	Coils			
10A/10421	A	1		M/O 142-250 kc/s
10A/10422	B	1		M/O 250-500 kc/s
				Inter. 142-250 kc/s
10A/10423	C	1		M/O 500-1,000 kc/s
				Inter. 250-500 kc/s
10A/10424	D	1		M/O 1-2 Mc/s
				Inter. 500-1,000 kc/s
10A/10425	E	1		Inter. 1-2 2 Mc/s
				Aerial, 500-9,000 kc/s
10A/10426	G	1		Fitted with:—
				10A10439, knob, slow-motion
10A/10427	H	1		M/O 2-4.7 Mc/s
10A/10428	J	1		Inter. 2-4.7 Mc/s
10A/10429	K	1		Aerial 2-4.6 Mc/s
10A/10430	L	1		M/O 4.7-10 Mc/s
10A/10431	M	1		Inter. 4.7-10 Mc/s
10A/10432	N	1		Aerial 4.7-10 Mc/s
10A/10433	P	1		M/O 10-20 Mc/s
10A/10434	Q1	1		Inter. 10-15 Mc/s
10A/10435	Q2	1		Inter. 15-20 Mc/s
10A/10436	R	1		Aerial, 10-20 Mc/s
				Wire-matching unit, 6-20 Mc/s
				Fitted with:—
10A/10437	S	1		LOA/11267, knob, slow-motion, type 14
				Unit to be used with installation fitted with remotely fed aerial
10D/24	T	1		M/O 3.0-6.5 Mc/s
10D/25	U	1		Inter. 3.0-6.5 Mc/s
10D/26	V	1		Aerial 3.0-6.5 Mc/s
10A/7543	Plug, type 55	1		For tone control
10A/7276	Socket, type 11	1		
10A/10571	Tone control	1		Fitted with:—
				Condenser, Type 381 ... 3
				Type 424 ... 2
10A/10557	Valve V.T. 45	2	V ₂ , V ₄	Master-oscillator and modulator
10A/10558	V.T. 46	1	V ₁	Intermediate
10A/10559	V.T. 47	1	V ₃	Amplifier

FOR OFFICIAL USE ONLY

AIR PUBLICATION 1186

Volume I

(Issued April, 1941,
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SECTION 1, CHAPTER 9

BLIND APPROACH TRANSMITTERS T.1122 AND T.1123

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TABLE 1
COMPONENT VALUES, UNIT A

C ₁	200 $\mu\mu\text{F}$.	C ₉	25 $\mu\mu\text{F}$.	C ₁₇	0.01 μF .	C ₂₅	0.01 μF .	R ₁	100 Ω	R ₉	10,000 Ω	R ₁₇	—
C ₂	300 $\mu\mu\text{F}$.	C ₁₀	29 $\mu\mu\text{F}$.	C ₁₈	20 $\mu\mu\text{F}$.	C ₂₆	0.1 μF .	R ₂	10,000 Ω	R ₁₀	10,000 Ω	R ₁₈	—
C ₃	200 $\mu\mu\text{F}$.	C ₁₁	0.01 μF .	C ₁₉	20 $\mu\mu\text{F}$.	C ₂₇	0.1 μF .	R ₃	10,000 Ω	R ₁₁	1,000 Ω	R ₁₉	500 Ω
C ₄	200 $\mu\mu\text{F}$.	C ₁₂	0.01 μF .	C ₂₀	40 $\mu\mu\text{F}$.	C ₂₈	0.1 μF .	R ₄	15,000 Ω	R ₁₂	500 Ω		
C ₅	0.01 μF .	C ₁₃	0.01 μF .	C ₂₁	50 $\mu\mu\text{F}$.	C ₂₉	0.01 μF .	R ₅	10,000 Ω	R ₁₃	750 Ω		
C ₆	0.01 μF .	C ₁₄	20 $\mu\mu\text{F}$.	C ₂₂	100 $\mu\mu\text{F}$.	C ₃₀	0.01 μF .	R ₆	10,000 Ω	R ₁₄	200 Ω		
C ₇	0.01 μF .	C ₁₅	40 $\mu\mu\text{F}$.	C ₂₃	0.01 μF .			R ₇	10,000 Ω	R ₁₅	105 Ω		
C ₈	20 $\mu\mu\text{F}$.	C ₁₆	0.01 μF .	C ₂₄	0.01 μF .			R ₈	50 Ω	R ₁₆	—		

TABLE 2
COMPONENT VALUES, UNITS B, C, and J

Unit B

C ₁	0.001 μF .	R ₁	50 Ω
C ₂	0.01 μF .	R ₂	20 Ω
C ₃	0.01 μF .	R ₃	2 $\times$ 15,000 Ω
C ₄	—		
C ₅	—		
C ₆	—		
C ₇	0.1 μF .		
C ₈	0.001 μF .		

Unit C

C ₁	0.001 μF .	C ₉	0.001 μF .
C ₂	0.001 μF .	C ₁₀	0.01 μF .
C ₃	0.01 μF .	R ₁	50 Ω
C ₄	0.01 μF .	R ₂	75 Ω
C ₅	—	R ₃	75 Ω
C ₆	—	R ₄	100 Ω
C ₇	—		
C ₈	—		

Unit J

R ₁	5,000 Ω
C ₁	0.001 μF .

TABLE 3

COMPONENT VALUES, UNITS D, E AND F

Unit D

C_1	100 $\mu\mu\text{F.}$	R_1	2,500 Ω
C_2	100 $\mu\mu\text{F.}$	R_2	1,000 Ω
C_3	0.2 $\mu\text{F.}$	R_3	10,000 Ω
C_4	2.0 $\mu\text{F.}$	R_4	500 Ω
C_5	1.0 $\mu\text{F.}$	R_5	2,500 Ω
C_6	4.0 $\mu\text{F.}$	R_6	140 Ω
C_7	4.0 $\mu\text{F.}$	R_7	
C_8	0.1 $\mu\text{F.}$		
C_9	0.1 $\mu\text{F.}$		

Unit E

C_1	4.0 $\mu\text{F.}$
C_2	10.0 $\mu\text{F.}$
C_3	4.0 $\mu\text{F.}$
R_1	
R_2	
R_3	
R_4	
R_5	

Unit F

R_1	
R_2	
R_3	
R_4	
R_5	

TABLE 4

COMPONENT VALUES, UNITS G and H

Unit G

C ₁	10.0 Fμ.	C ₅	10.0 μF.	C ₉	10.0 μF.
C ₂	10.0 μF.	C ₆	10.0 μF.	C ₁₀	10.0 μF.
C ₃	10.0 μF.	C ₇	10.0 μF.	C ₁₁	10.0 μF.
C ₄	10.0 μF.	C ₈	10.0 μF.		

Unit H

C ₁	4.0 μF.
C ₂	4.0 μF.
C ₃	4.0 μF.
C ₄	4.0 μF.

TABLE 5

COMPONENT VALUES, UNIT R

C ₁	180 μμF.	C ₁₁	15 μμF. Max.	C ₂₁	25 μμF. Max.	C ₃₁	25 μF.	R ₁	10,000 Ω	R ₁₁	100 Ω	R ₂₁	—
C ₂	800 μμF.	C ₁₂	220 μμF. Max.	C ₂₂	90 μμF.	C ₃₂	10 μF.	R ₂	20 Ω	R ₁₂	2,500 Ω	R ₂₂	500 Ω
C ₃	500 μμF.	C ₁₃	0.01 μF.	C ₂₃	60 μμF.	C ₃₃	10 μF.	R ₃	10,000 Ω	R ₁₃	500 Ω	R ₂₃	10 Ω
C ₄	0.01 μF.	C ₁₄		C ₂₄	14 μμF.	C ₃₄	4.0 μF.	R ₄	10,000 Ω	R ₁₄	25,000 Ω		
C ₅	0.002 μF.	C ₁₅	0.01 μF.	C ₂₅	0.01 μF.	C ₃₅	2.0 μF.	R ₅	5,000 Ω	R ₁₅	50,000 Ω		
C ₆	—	C ₁₆	0.01 μF.	C ₂₆	0.01 μF.	C ₃₆	6.0 μF.	R ₆	10,000 Ω	R ₁₆	5,000 Ω		
C ₇	15 μμF. Max.	C ₁₇	0.01 μF.	C ₂₇	0.172 μF.	C ₃₇	—	R ₇	500 Ω	R ₁₇	12 Ω		
C ₈	65 μμF. Max.	C ₁₈	25.0 μF.	C ₂₈	2 × 0.01 μF.	C ₃₈	9 μμF.	R ₈	10,000 Ω	R ₁₈	2,000 Ω		
C ₉	0.01 μF.	C ₁₉	15 μμF. Max.	C ₂₉	0.04 μF.	C ₃₉	0.007 μF.	R ₉	2,000 Ω	R ₁₉	2,000 Ω		
C ₁₀	25 μμF.	C ₂₀	15 μμF.	C ₃₀	—	C ₄₀	0.01 μF.	R ₁₀	250 Ω	R ₂₀	7,500 Ω		

TABLE 6

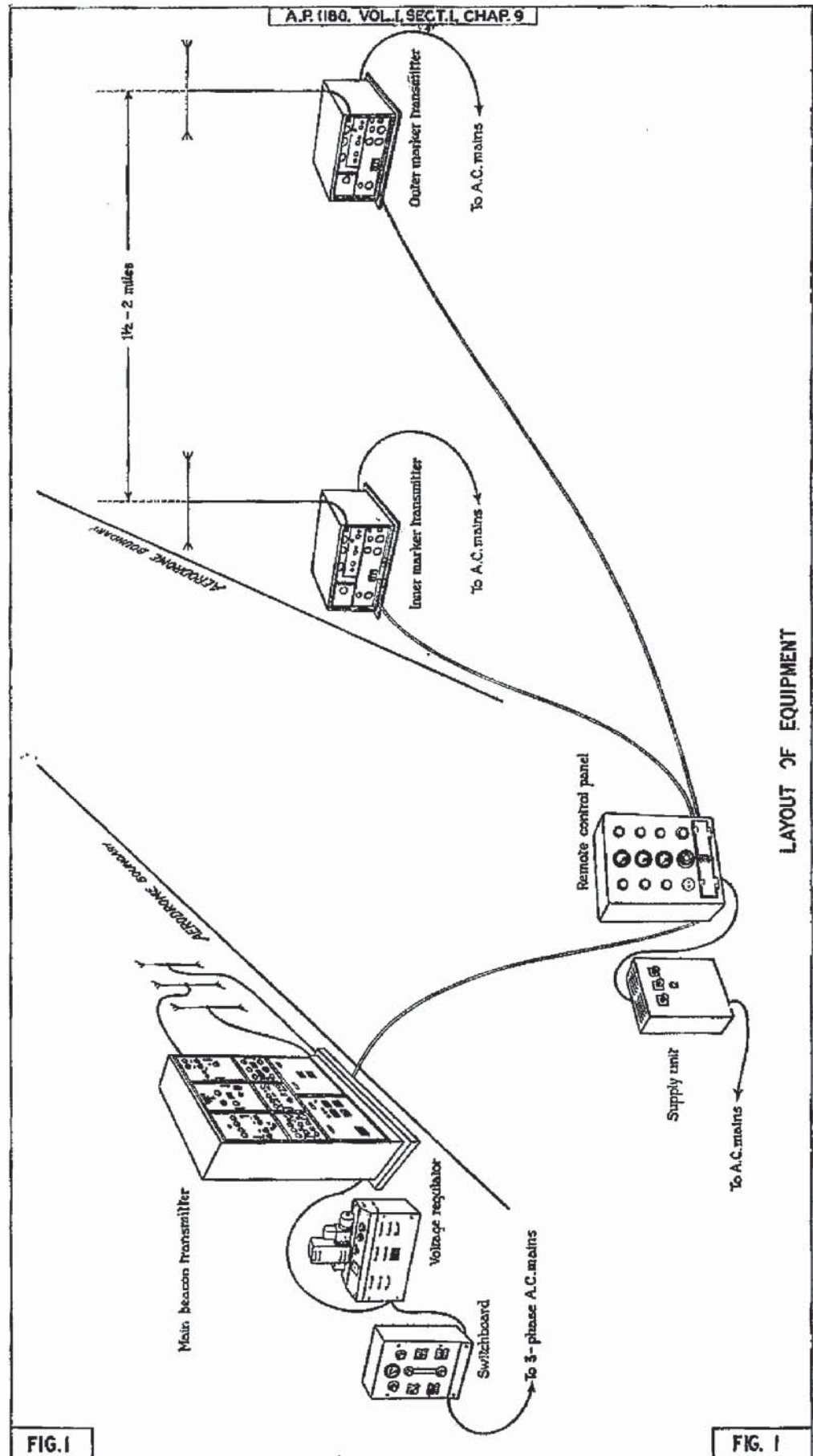
COMPONENT VALUES, UNITS P AND S

Unit P

C_1	$0.5 \mu\text{F.}$	C_6	$2.0 \mu\text{F.}$	C_4	$2.0 \mu\text{F.}$
C_2	$0.5 \mu\text{F.}$	C_7	$2.0 \mu\text{F.}$	C_{12}	$2.0 \mu\text{F.}$
C_3	$0.5 \mu\text{F.}$	C_8	$2.0 \mu\text{F.}$	C_{13}	$2.0 \mu\text{F.}$
C_4	$80 \mu\text{F.}$	C_9	$2.0 \mu\text{F.}$	C_{14}	$2.0 \mu\text{F.}$
C_5	$2.0 \mu\text{F.}$	C_{10}	$2.0 \mu\text{F.}$	C_{15}	$2.0 \mu\text{F.}$

Unit S

C_1	$0.1 \mu\text{F.}$
C_2	$0.1 \mu\text{F.}$
C_3	$0.1 \mu\text{F.}$
R_1	120Ω



BLIND APPROACH TRANSMITTERS T.1122 AND T.1123

INTRODUCTION

1. The blind approach transmitter equipment consists of a main beacon transmitter, marker beacon transmitters and the requisite control and supply panels. The transmitters are intended to provide the radiation fields necessary to enable blind approach receivers to be employed by aeroplanes landing at aerodromes at which the equipment is installed. An account of the radiation fields and their use has been given in connection with the blind approach receiver in another chapter of this publication. The complete installation normally consists of one transmitter, type T.1122, two transmitters, type T.1123, and a remote control from which all three transmitters are operated. The general arrangement of the installation is shown diagrammatically in fig. 1.

2. The main beacon transmitter, type T.1122, marks the approach course, radiating an aerial power of 500 watts at a fixed frequency in the band between 30.5 and 40.5 Mc/s. The output, which is modulated to a depth of 90 per cent. at a frequency of 1,150 c/s, is fed to a vertical half-wave dipole aerial, at opposite sides of which, in a plane at right angles to the approach path, are two parallel reflector aeriels. These reflector aeriels, which are spaced approximately one-quarter of a wavelength from the main aerial, each consist of two independent quarter-wave sections. These reflectors are set in operation alternately, by connecting their sections together through keying relays operated by the transmitter. The keying impulses, which have a duration of one-eighth of a second, occur once per second.

3. The marker beacon transmitters, type T.1123, radiate at a fixed frequency of 38 Mc/s. The output power, 5 watts, is delivered to a horizontal dipole aerial below which is a gauze reflector screen. The output is modulated to a depth of 90 per cent., and is also automatically keyed. The inner marker beacon, which is installed near the aerodrome boundary on the approach path, is modulated at a frequency of 1,700 c/s and the output is keyed into dots of duration one-fifteenth of a second, six dots being radiated per second. The outer marker is installed along the approach line, about two miles from the inner marker, and is modulated at 700 c/s. The output is keyed into long dashes at the rate of two per second, the duration of each dash being two-fifths of a second. The transmitters include all the modulation and keying apparatus for use either as inner or as outer markers.

4. The approach path is arranged along the best direction for a blind approach to the aerodrome, and this direction is generally used. Facilities are available, however, in the design of the system, which permit the installation of a reciprocal approach path on a course 180 degrees different from the normal approach path, if the aerodrome facilities permit. Where the reciprocal approach path is installed there will be two further marker beacons situated along the reciprocal course. These are known as the reciprocal inner marker and the reciprocal outer marker.

5. When the reciprocal approach path is used, the keying of the reflector aeriels is interchanged so that dots are still radiated to the port side of an aeroplane on the approach path. Provision for this changeover in keying is made in the main beacon transmitter. The changeover may also be made from the remote control position, which also switches on the marker beacon transmitters appropriate to the approach course selected.

6. The remote control equipment, which may be installed in any convenient position, provides facilities for switching all the transmitters on or off, and for selecting the normal or reciprocal path. Provision is also made for return indications which show whether all the transmitters are operating correctly as regards output power, modulation, and keying.

7. The entire system is designed for 50 c/s A.C. mains operation, a 6-kW. three-phase supply at any voltage between 360 and 440 being necessary for the main beacon transmitter, and 500-watt single-phase 50 c/s A.C. supplies for the remote control and for the marker beacon transmitters. The single-phase supply may be of any voltage between 200 and 245, or at 110 or 115 volts. All the necessary controls and rectifiers are included in the equipment.

GENERAL DESCRIPTION

8. The apparatus comprising the main beacon and the marker beacon transmitters is divided into sections for descriptive purposes. Each section, which corresponds to one of the assemblies or units of the equipment, is identified on the diagrams by a reference letter. These reference letters are appended as suffixes to the component numbers, so as to indicate the section in which the component is identified. The theoretical circuit diagram of the transmitter T.1122 is given in four parts, namely figs. 2, 3, 6 and 7.

Main beacon

9. From the theoretical circuit diagram, fig. 2, which represents the R.F. stages of the transmitter, it will be seen that the exciter unit, section A, includes a push-pull amplifier, stage 3, consisting of the valves V_{4A} and V_{5A} , supplying the R.F. transformer, T_{2A} , whose primary winding is tuned by the variable condenser C_{20A} . Cross neutralisation is applied by the variable condensers C_{18A} and C_{19A} , the H.T. feed being applied to the centre tapping of the primary winding through a decoupling circuit and an anode current meter.

10. The grid circuit drive is provided by the secondary winding of the transformer, T_{1A} , whose centre tapping is connected to the grid-bias control on section E through a potentiometer consisting of the resistances R_{10A} and R_{11A} . The primary winding of the transformer, which forms the load circuit of the valve V_{3A} , is supplied with H.T. at its centre tapping through an anode current milliammeter and a decoupling circuit. The winding is tuned by the variable condenser C_{15A} , neutralisation being provided by the condenser C_{14A} .

11. The grid circuit of the valve V_{3A} , stage 2, is driven by the mixed outputs of the crystal oscillator valve V_{1A} and the R.F. oscillator valve V_{2A} . The outputs are coupled to the grid through the condensers C_{9A} and C_{1A} respectively. Interaction between the oscillators is obviated by the choke L_{5A} .

12. Automatic grid bias is provided by the D.C. component of the grid current which sets up the required grid-bias voltage in its passage through the resistances R_{6A} and R_{9A} to the earthed cathode of the valve. Additional bias is applied across the resistance R_{9A} by the anode current of the regulator valve V_{8A} , which acts as a rectifier of a portion of the R.F. output of the valves V_{4A} and V_{5A} should the R.F. voltage, developed across the primary winding of the transformer T_{2A} , exceed the grid-bias voltage existing across the resistances R_{10A} and R_{11A} . The automatic output control thus provided by the regulator valve is unnecessary where the glide path of the transmitter is not in use, and the valve is not then fitted in position.

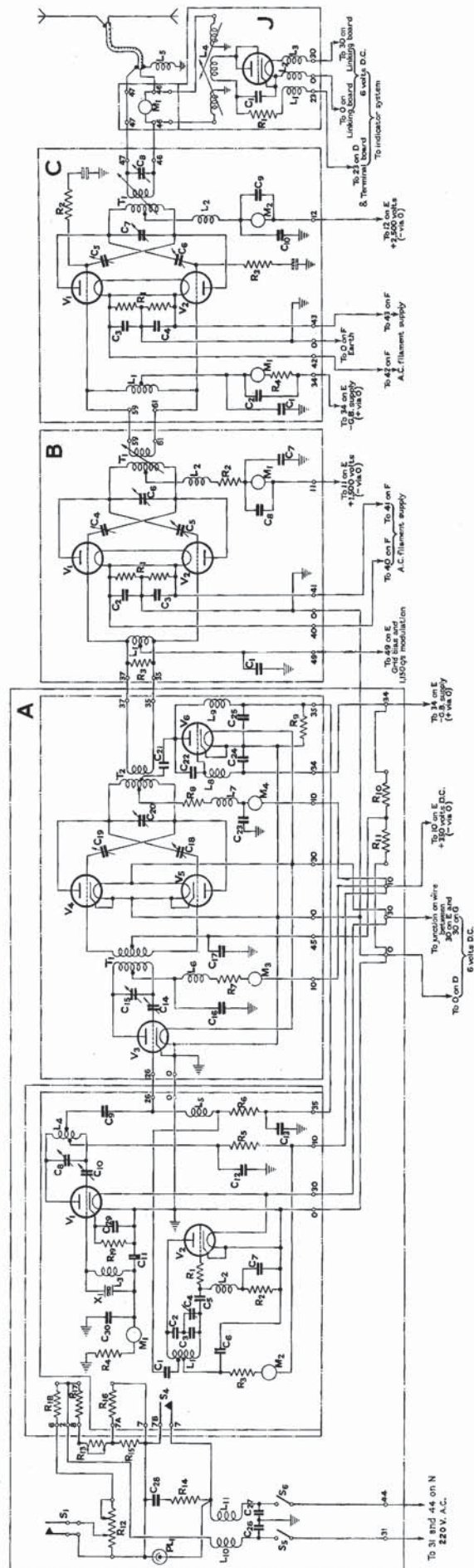
13. The crystal oscillator valve V_{1A} is connected in a conventional circuit, the crystal X_1 forming the grid circuit, and the inductance L_{4A} , tuned by the variable condenser C_{3A} forming the anode circuit. The feedback coupling provided by the anode-grid interelectrode capacitance of the valve is offset by the neutralising condenser C_{10A} , which is adjusted so as to apply a very small drive to the crystal, in order to obviate spurious oscillation of the crystal at unwanted frequencies. The grid bias of the crystal oscillator is provided partly by the D.C. component of the cathode current in its passage through the resistance R_{19A} , and partly by the D.C. component of the grid current which passes to earth through the resistance R_{4A} and the grid current meter M_{1A} .

14. In order to obviate the need for grinding the crystals to resonate exactly at the frequency prescribed for the transmitter, the series-fed Hartley connected R.F. oscillator valve V_{2A} is provided. This valve acts as a heterodyne oscillator or R.F. modulator, and is used as a vernier adjustment of the carrier frequency of the transmitter.

15. The anode circuit of the mixer valve V_{3A} is usually tuned to the sum of the frequencies of the two oscillator valves. To ensure a high degree of frequency stability, the valves and components of the two oscillators are enclosed in an oven whose temperature is maintained at exactly 50 deg. C. by the heating resistances R_{16A} , R_{17A} and R_{18A} which are supplied with A.C. through the overload release switches S_{5A} and S_{6A} and a R.F. filter consisting of the chokes L_{12A} and L_{11A} and the associated condensers C_{26A} and C_{27A} . The heater circuit is controlled by two thermostat switches S_{1A} and S_{4A} , the former being set at 15 degrees and controlling the temperature of the whole exciter unit. Across the contacts of the latter is connected the lamp PL_{1A} and a spark suppressor consisting of the resistance R_{14A} and the condenser C_{28A} .

16. The supplies for the valves in section A comprise 6.3 volts D.C. for the heaters, connected to terminals 0 and 30, and 350 volts H.T. for the anodes, connected to terminals 0 and 10. These

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T.1122. UNITS A, B, C AND J. THEORETICAL CIRCUIT DIAGRAM

supplies are obtained from the L.T. rectifier, section G. The grid bias supply for the valves V_{4A} and V_{5A} of stage 3, is connected through terminal 34 to the D.C. control unit, section E. The oven heater supply, 220 volts A.C., is obtained *via* terminals 31 and 44 from the voltage-regulator, section M.

17. The grid circuit of the neutralised push-pull valves V_{1B} and V_{2B} , which comprise stage 4 or section B of the transmitter, is provided by the inductance L_{1B} which is excited by the secondary winding of the transformer T_{2A} of stage 3. The centre tapping of the inductance is earthed by the condenser C_{1B} and connected *via* the terminal 49 to the grid-bias and modulation circuits contained in section E. The valves are directly heated by a 7.5 volts A.C. supply obtained through terminals 40 and 41 from section F, the filaments being centre-pointed to earth by the resistance R_{1B} and by the condensers C_{2B} and C_{3B} . The anode load circuit of the valves consists of the transformer T_{1B} , whose primary winding is tuned by the variable condenser C_{4B} , and fed at its centre tapping with H.T. at 1,500 volts, obtained from section H *via* terminal 11 through the anode current meter M_{1B} and a decoupling circuit.

18. The secondary winding of the transformer T_{1B} is variably coupled to the primary, and connected to the aperiodic grid inductance L_{1C} of the valves V_{1C} and V_{2C} of stage 5 of the transmitter, section C. The centre point of this inductance is connected to the grid bias terminal, number 34, through the grid current meter M_{1C} , and a decoupling circuit. The resistances R_{2C} and R_{3C} are connected to the grids of the valves to prevent parasitic oscillation; the unconnected ends of the resistances may be considered to be connected to earth through their self capacitances, which are shown dotted. The heater circuit of the valves resemble that of stage 4, the heater terminal numbers being 42 and 43. The anode circuit of the valves, consisting of the primary winding of the transformer T_{1C} and its tuning condenser C_{7C} , is otherwise similar to that of stage 4. The variably coupled secondary winding is tuned, and connected *via* the aerial current meter M_{1J} on the indicator and coupling unit, section J, to a concentric feeder leading to the dipole aerial. The outer sheath of the feeder is connected to the upper member of the dipole, and the inductance L_{50} is provided to by-pass static charges to earth.

19. The indicator of section J consists of a triode valve V_{1J} whose grid and anode are strapped together making the valve as a diode. The anode-cathode circuit is supplied with R.F. *via* the centre section of the triple coil L_{4J} , whose symmetrically placed outer sections are connected to earth and to pick-up rods in the coupler compartment. The rectified output voltage developed across the resistance R_{1J} , filtered by the R.F. chokes L_{1J} and L_{2J} and the condenser C_{1J} , is led *via* the terminals 0 and 23 of the control unit, section D. The 6.3 volt heater supply is provided *via* terminals 0 and 30, the choke L_{2J} assisted by L_{3J} excluding R.F. from the D.C. feed lines.

20. *Reflector switching.*—As has been explained elsewhere in this chapter, the equi-signal zone necessary for course indication is provided by alternate keying of the reflectors on either side of the transmitting aerial. This is accomplished by relay boxes, sections K and L, which are shown in the theoretical circuit diagram, fig. 3, together with the associated control equipment of the transmitter.

21. The reflector aeriels operate only when the switches, placed at their current antinodes, are closed. These switches consist of the relays REL_{1K} and REL_{1L} , whose windings are connected in series. When unenergised, the contacts of one are open while the contacts of the other are closed. When the keying contacts are closed the relays are energised and the aerial switching is reversed, the normally closed contacts of the one relay being opened and the normally open contacts of the other relay being closed. The radiation is thus reflected from one side to the other. The conditions during "normal" operation of the transmitter, when dots are radiated to the port side of an aeroplane on the approach path, are shown in the diagram, fig. 4. In fig. 4A the port reflector switch is shown closed and the radiation is reflected to starboard for the period during which the keying contacts are open. The conditions when the keying contacts are closed are shown in fig. 4B. During the short closed period a "dot" is reflected to port. The relation between the dot and dash radiations, the ratio of which is 1 : 7, is illustrated in fig. 4C. The field strength curves considered in A and B cut at the point x . Reception at the point x is constant whichever reflector is operating. If other field strength curves are drawn they will intersect as shown at the points y , at points which lie in a straight line with the radiating aerial. The line through x and y , termed the Q.D.M. line is thus the approach patch, that is, the only path along which reflection has no effect on the strength of the received signal. To the right

of this line the field strength during dash periods exceeds that during dot periods and therefore dashes are superimposed on the steady field strength, becoming relatively stronger as the distance to the right increases. To the left, dots are superimposed. For practical purposes the "line" through x and y is a sector whose angle is generally not more than four degrees. This is due to the fact that the receivers employed are insensitive to changes in field strength of less than 5 per cent.

22. In practice, it is impossible to construct relays to operate simultaneously, and, it is therefore customary to adjust them in pairs so that one relay opens its contacts between two and six milliseconds before the other relay closes. During the period intervening between the opening of one set of contacts, and the closing of the other, the signal transmitted is that due to the dipole alone, which is shown chain-dotted in fig. 4c. It is necessary to adjust the aeriols in practice so that the field strength due to the dipole alone, at any point along the line xy exactly equals that due to the reflectors, so that this field strength curve also passes through x and y , as shown. In these conditions, therefore, the field strength along the approach path is invariable.

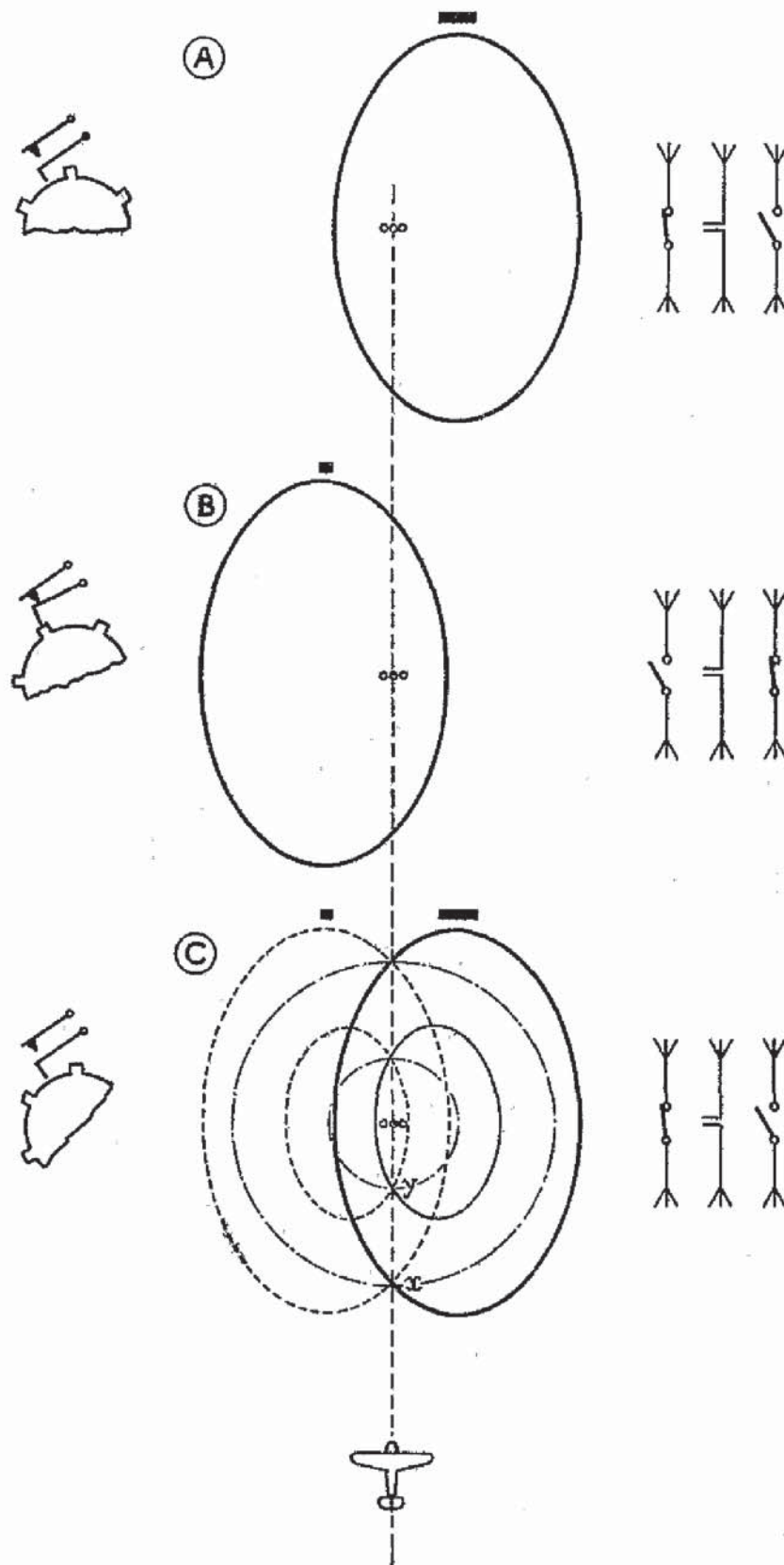
23. Referring to fig. 3, the exciting winding of the relay REL_{1K} is connected through the R.F. chokes L_{1K} and L_{2K} and terminals 28 and 45, by a screened cable to a linking strip. That of the relay REL_{1L} is connected similarly through terminals 9 and 45 to the same strip. At the linking strip, terminals 45 are connected together, terminal 9 being connected to one pole of the 25-volt D.C. supply on section G. Terminal 28 also receives 25-volt D.C. from the other pole, through the modulation and keying unit, section D, which incorporate a variable resistance R_{6D} enabling the operating current of the relays to be adjusted to a 150 mA.

24. *Modulation and keying unit.*—Section D incorporates the apparatus necessary for modulating the transmitter, and keying the reflector aeriols. This apparatus includes a three-phase synchronous motor-generator fed from the main A.C. supply through terminals 1, 2 and 3, the three-pole switch S_{6D} and the overload release switches S_{7D} and S_{8D} . This motor-generator drives four keying wheels numbered 1, 2, 3 and 4 which interrupt the 25-volt supply to the relays, sections K and L, at the predetermined frequency. Wheels numbers 1 and 3 provide "normal" keying, number 3 being a spare; wheels numbers 2 or 4 are used when a "reciprocal" approach path is required, number 4 being the spare. The reciprocal wheels close the keying contacts for long, or dash, periods, and leave them open for short periods. As previously explained, a 25-volt D.C. supply is used to operate the relays REL_{1L} and REL_{1K} , the positive being taken to terminal 9 on section L. The current passes through the choke L_{1L} , the relay REL_{1L} and the choke L_{2L} to terminal 45, thence *via* the linked terminals 45 on the terminal board to terminal 45 on section K where it passes through the choke L_{2K} , the relay REL_{1K} , and the choke L_{1K} and so to terminal 28 on section D. Here it passes through the resistance R_{6D} and the winding of the relay REL_{3D} which controls the indicator lamps PL_{1D} , PL_{2D} , PL_{3D} and PL_{4D} . From the relay REL_{3D} the circuit continues to the common side of the four sets of keying contacts and to one of the "hand keying" terminals. When the switch S_{3D} is in the HAND position, the circuit is completed *via* the hand key, shunted by a spark quenching circuit consisting of the resistance R_{4D} and the condenser C_{5D} , to the negative of the 25-volt supply *via* terminal 8. When the switch S_{3D} is in the AUTO position, the circuit is completed *via* one of the keying wheels, one side of the SPARE-NORMAL switch S_{3D} and one set of contacts of the relay REL_{1D} . This set of relay contacts selects either the "normal" pair of keying wheels or the "reciprocal" pair. The SPARE-NORMAL switch S_{3D} selects either the normally used or spare wheel of the two selected by the relay REL_{1D} .

25. The pilot lamps PL_{1D} , PL_{2D} , PL_{3D} , and PL_{4D} indicate which of the four keying wheels is in use and that the keying circuit is opening and closing properly. The lamps PL_{2D} and PL_{4D} are green and show that "normal" keying is in operation, while the remaining lamps are red and indicate that "reciprocal" keying is in use. When the spare wheels are in use the lamp PL_{3D} or PL_{4D} will light while the lamps PL_{1D} and PL_{2D} indicate normal use.

26. The second half of the switch S_{3D} and the end set of contacts of the relay REL_{1D} select the lamp appropriate to the wheel in use. Current for the lamps is obtained from one secondary of the transformer T_{3D} , the primary of which is fed by single-phase A.C. *via* terminals 1 and 3. The circuit of the lamp supply is from one side of the secondary winding to the appropriate lamp, one side of the switch S_{3D} , one set of contacts of the relay REL_{1D} , and one set of contacts of the relay REL_{3D} which close in the keying rhythm and cause the lamp to flash.

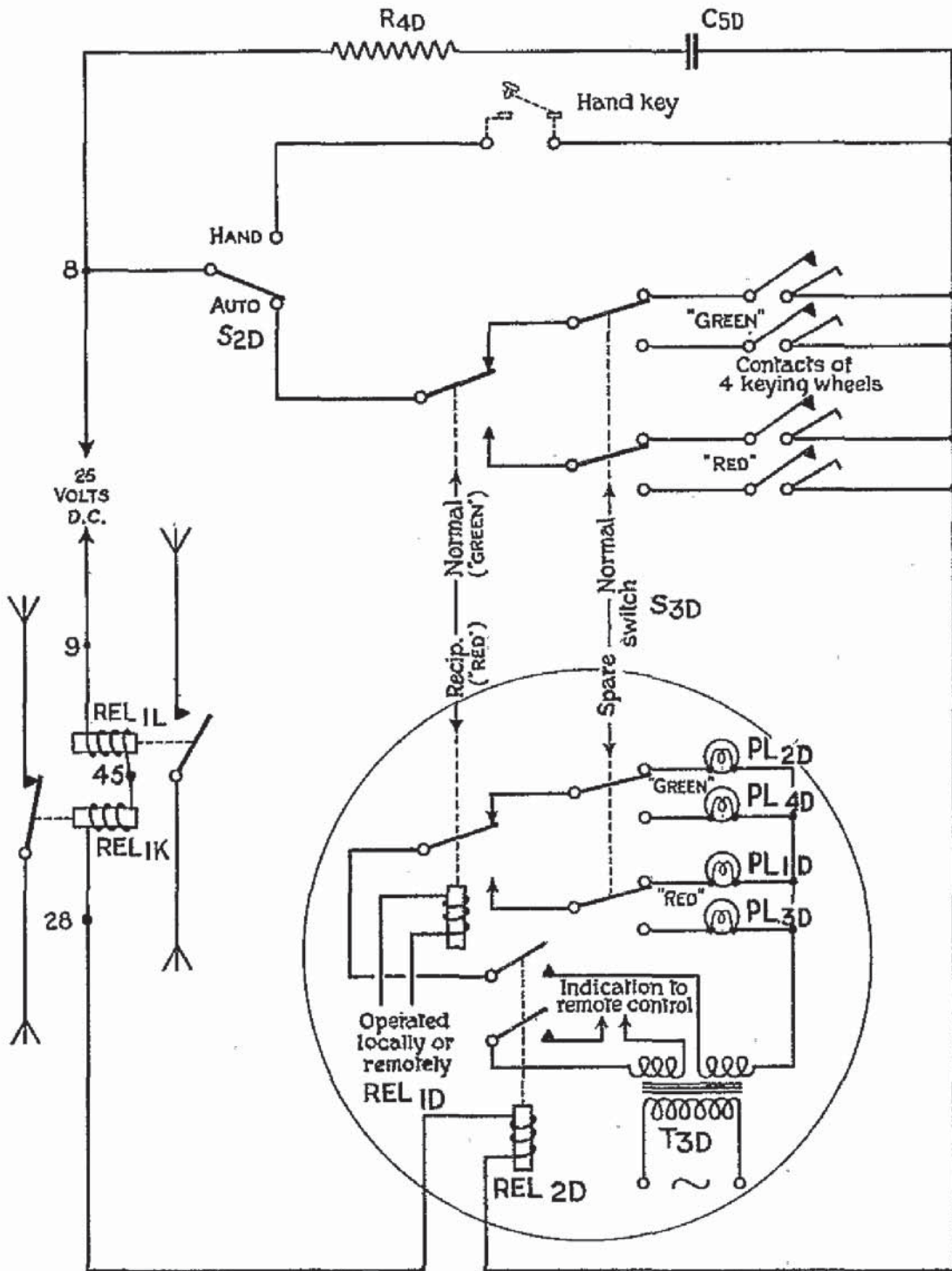
27. The relay REL_{1D} , which changes the transmitter from "normal" (green) path to "reciprocal" (red) path, is operated from the 250-volt D.C. supply *via* terminals 0 and 65.



RADIATION DIAGRAM FOR MAIN BEACON

FIG.4

FIG.4



T.1122
SIMPLIFIED KEYING AND
MODULATION CIRCUITS

FIG. 5

FIG. 5

When the switch S_{1D} is pressed momentarily to "reciprocal," the relay REL_{1D} is energised and remains energised because current is thereafter supplied to it *via* two of its own contacts. To interrupt this current and thus return the transmitter to "normal" operation, the switch S_{1D} is set momentarily to "normal" and opens the circuit.

28. This relay may also be operated through the contacts of the relay REL_{2D} which is energised by current from the remote control panel *via* terminals 26 and 27. The other secondary winding of the transformer T_{3D} supplies a return indication current for the remote control panel. This current is interrupted in keying rhythm by the second set of contacts of the relay REL_{3D} and travels *via* terminals 24 and 25, or 26 and 27, according to whether the relay REL_{1D} is in the "normal" or "reciprocal" position. A simplified diagram of the keying and keying indication circuits is given in fig. 5.

29. Referring to fig. 3, the excitation of the motor-generator is obtained from the 250-volt supply *via* terminals 0 and 65, the overload release switch S_{5D} , the resistance R_{2D} , and the potentiometer R_{1D} . The output of the generator, whose frequency is 1,150 c/s is applied to the transformer T_{2D} whose secondary voltage, measured by the voltmeter M_{1D} in conjunction with the resistance R_{7D} , is applied through the terminals 19 and 29 to the grid circuit of section B for modulation purposes.

30. The output of the rectifier valve V_{1T} is received through terminals 0 and 23 and passes through the primary of transformer T_{1D} and the meter M_{3D} . The D.C. component of the rectified current, indicating the carrier strength, is measured on this meter. The A.F. component is applied through the secondary winding of T_{1D} either to the meter M_{2D} or to the remote control panel *via* terminals 20 and 21 as determined by the setting of the switch S_4 . The meters M_{2D} and M_{3D} together indicate the modulation depth.

31. *Supply circuits.*—Section E of the transmitter is the metering panel for checking the voltage of the supplies, and also contains the grid bias control and the starting switches and relays of the transmitter. The 6-volt D.C. supply enters section E by terminals 0 and 30 and is applied to the pilot lamp PL_{1E} . The voltage is checked by the meter M_{1E} when the switch S_{3E} is set into the 6V position. The same switch and another range of the same meter are used to check the 25-volt supply. The meters M_{2E} and M_{3E} are used to measure the voltages of the 250 and 350-volt supplies, and the 1,500 and 2,500-volt supplies respectively. They are controlled by the switches S_{4E} and S_{5E} and tapped resistances. The 250-volt grid bias supply, after passing through a smoothing circuit consisting of the choke L_{1E} and the condenser C_{2A} is connected to a potentiometer resistance R_{13E} , whose tapping is connected to terminal 34, to supply the grid bias for stages 3 and 5.

32. The four-pole switch S_{6E} has two positions, designated TUNE and NORMAL. When in the NORMAL position, the right-hand set of contacts connects grid bias terminal, number 49, of stage 4 to terminal 29, thence, through the modulation transformer T_{2D} on the control unit, section D, to terminal 19, and thence through the automatic grid-bias resistances R_{4E} and R_{5E} to earth. In the TUNE position of the switch terminal 49 is connected directly to a tapping on the resistance R_{5E} , thus omitting the modulation and decreasing the grid bias. At the same time, the remaining contacts of the switch reduce the H.T. voltage applied to stage 5, as described in a later paragraph. The functions of the switches S_{1E} and S_{2E} , and the relays REL_{1E} and REL_{2E} are described in the paragraphs dealing with the starting circuits and with the remote control, later in this chapter.

33. The A.C. supply unit, section F, incorporates the main A.C. control switch, S_{1F} , of the transmitter, the three position A.C. voltmeter switch S_{2F} and its associated voltmeter M_{1F} , and the A.C. ammeter M_{2F} . The other components are the fan which cools section C, and is controlled by the three-phase overload release switch S_{3F} . This switch has extra contacts, connected to terminals 32 and 32A, in series with the starting circuit. The transformer T_{1F} , controlled by the overload release switch S_{4F} , supplies the filament circuits of stages 4 and 5. The variable resistances R_{1F} , R_{2F} and R_{3F} serve to adjust the voltages to the correct values, which are checked by the A.C. voltmeter M_{3F} controlled by the voltmeter switch S_{5F} .

34. Referring to fig. 6, which gives the theoretical circuit diagram of the rectifier units, the 2,500-volt rectifier circuit of section H receives the three-phase A.C. supply from section F *via* terminals 1, 2 and 3. The three primary windings of the transformer T_{2H} are connected thereto through the overload release switch S_{2H} . The other ends of these windings are connected to

terminals 16, 17 and 18 and are connected together by the switch S_{6H} when in the TUNE position, thus connecting the transformer in "star." When the switch S_{6H} is set in the NORMAL position, these terminals are respectively connected to terminals 13, 14 and 15 thus connecting the transformer in "delta," applying a higher voltage per winding, and increasing the secondary voltage. The secondary windings are "star" connected to the three-phase full wave metal rectifier $RECT_{2H}$, whose D.C. output is connected through a smoothing circuit to terminals 0 and 12 to stage 5. The 1,500-volt rectifier circuit is similar except that the primary windings of the transformer T_{1H} are permanently "delta" connected, and receive their A.C. supplies from terminal 2, and from terminals 5 and 6 which are connected to terminals 3 and 1 by the contacts of the relay REL_{2G} , mounted in section G.

35. The winding of this relay REL_{2G} is excited by single-phase A.C. from terminals 2 and 3 when the relay REL_{3G} is operated, and the operation of this relay by the 25-volt D.C. output of the rectifier $RECT_{2G}$ is in its turn dependent upon the operation of the relay REL_{4G} by the rectifier $RECT_{5G}$ which is connected across the heater supply of stage 5, terminals 42 and 43. When the transmitter is first started up, the closing of the contacts of the relay REL_{4G} in the first place connects in circuit the thermal delay unit of the relay REL_{3G} . The thermal delay bends as it is heated by the current, until finally, after the lapse of approximately 40 seconds to allow the indirectly heated valves of section A to warm up, the bending is sufficient to establish the contact between the winding of the relay REL_{3G} and the 25-volt D.C. supply. The relay REL_{3G} then operates, and besides operating the relay REL_{2G} , its contacts disconnect the heater of the thermal delay, and establish an alternative path for exciting its own winding. This precaution ensures that no power is radiated until the exciter stages are ready for correct operation.

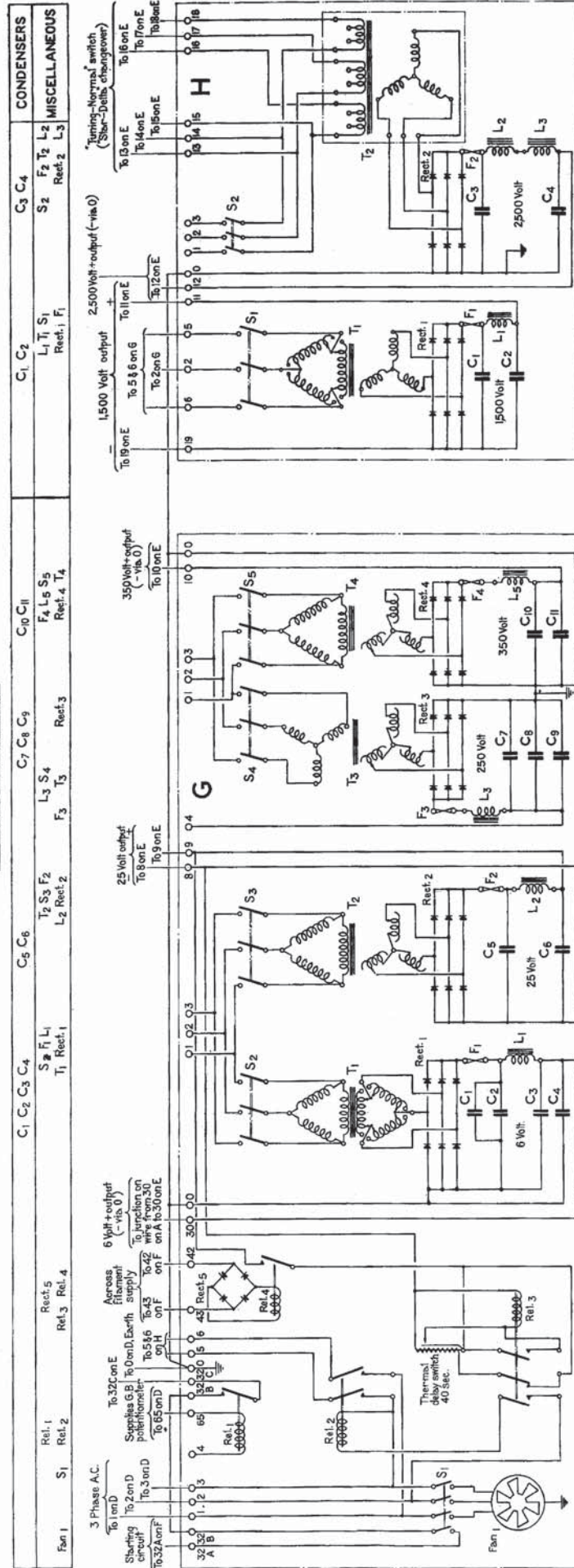
36. The circuits of the 6.3-volt, the 25-volt and the 350-volt rectifiers $RECT_{1G}$, $RECT_{2G}$ and $RECT_{4G}$ do not differ materially from those of section H. The 250-volt rectifier, $RECT_{3G}$, is also similar, except that its output is connected in series with the winding of the relay REL_{1G} which on operating short circuits together the terminals 32B and 32C which are in series with the starting circuit of the transmitter.

37. The terminals 37, 38 and 39 which supply the three-phase circuit of the transmitter via the supply unit, section F, are connected through the voltage regulator, section N, to the switch S_{1N} . The theoretical circuit diagram of this section and of the A.C. switchboard, section M, are given in fig. 7. When this switch is in the right hand, or UNREGULATED position, the terminals are connected through the contactor CB_{1N} to tappings on the auto transformer T_{1N} which is supplied with A.C. from the switchboard section M.

38. When the switch is in the REGULATED position, as shown, the terminals 37, 38 and 39 are similarly connected, the induction regulator REG_{1N} being, however, connected in series with the lines. The induction regulator serves to increase or decrease the A.C. voltage, and is operated by a servo motor, REG_{2N} , which is described in detail later in this chapter. The servo motor moves in response to changes in the mains voltage, which are applied through the voltmeter coil Bb and the controlling resistance R_{1N} . The operation of the servo motor depends on oil circulation provided by an electric motor, the heater Hh, in conjunction with the thermostat TH_{1N} maintaining the oil at a fixed temperature.

39. *Starting circuit.*—A simplified diagram of the starting circuit of the transmitter is given in fig. 8, from which it will be seen that there are two paths through which the main contactor CB_{1N} may be excited when an A.C. supply is available at terminals 31 and 44 of the voltage regulator. The path of the primary starting circuit, which is under the control of the local starting switches S_{1E} and S_{2E} , and of the remotely operated relay REL_{2E} , is shown by arrows. This circuit is only closed momentarily.

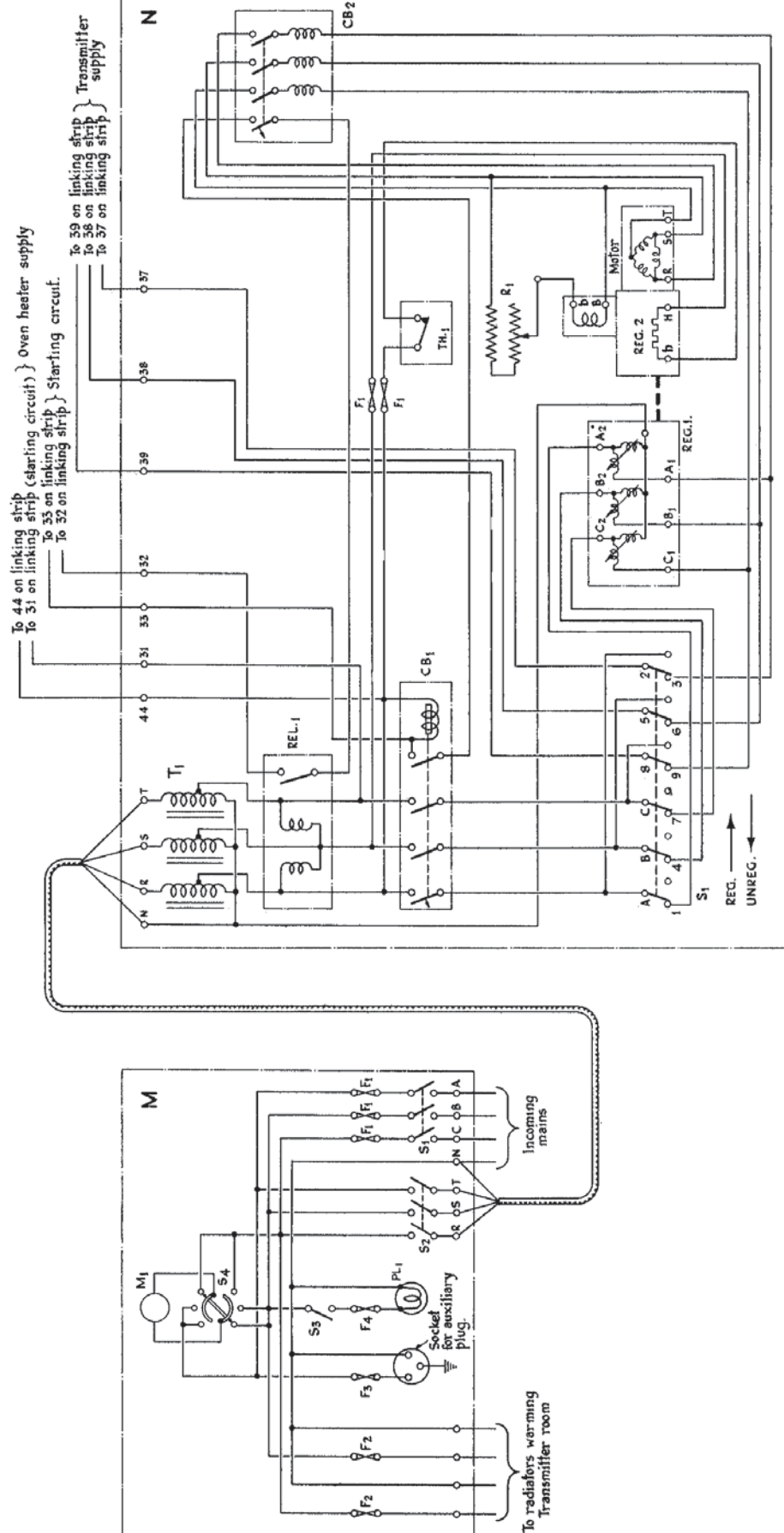
40. The temporary closing establishes a secondary starting or holding circuit from terminal 33 of the contactor CB_{1N} through one of its own contacts, through a contact of the circuit breaker CB_{2N} —contact of the relay REL_{1N} —terminal 32—contact of the switch S_{3F} —terminal 32A—contact of the switch S_{1G} —terminal 32B—contact of the relay REL_{1G} —terminal 32C—contacts of the switch S_{1E} and of the relay REL_{1E} —terminal 31. Thus the contactor CB_{1N} will only remain closed, after operation of the starting switches, provided that the circuit breaker CB_{2N} does not release due to overload, that the relay REL_{1N} has not released due to phase failure, that the fans on section F and G are switched on, and also that the grid bias circuits are established.



T. 1122. UNITS C AND H. THEORETICAL CIRCUIT DIAGRAM

FIG. 6

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T.1122, UNITS M AND N, THEORETICAL CIRCUIT DIAGRAM

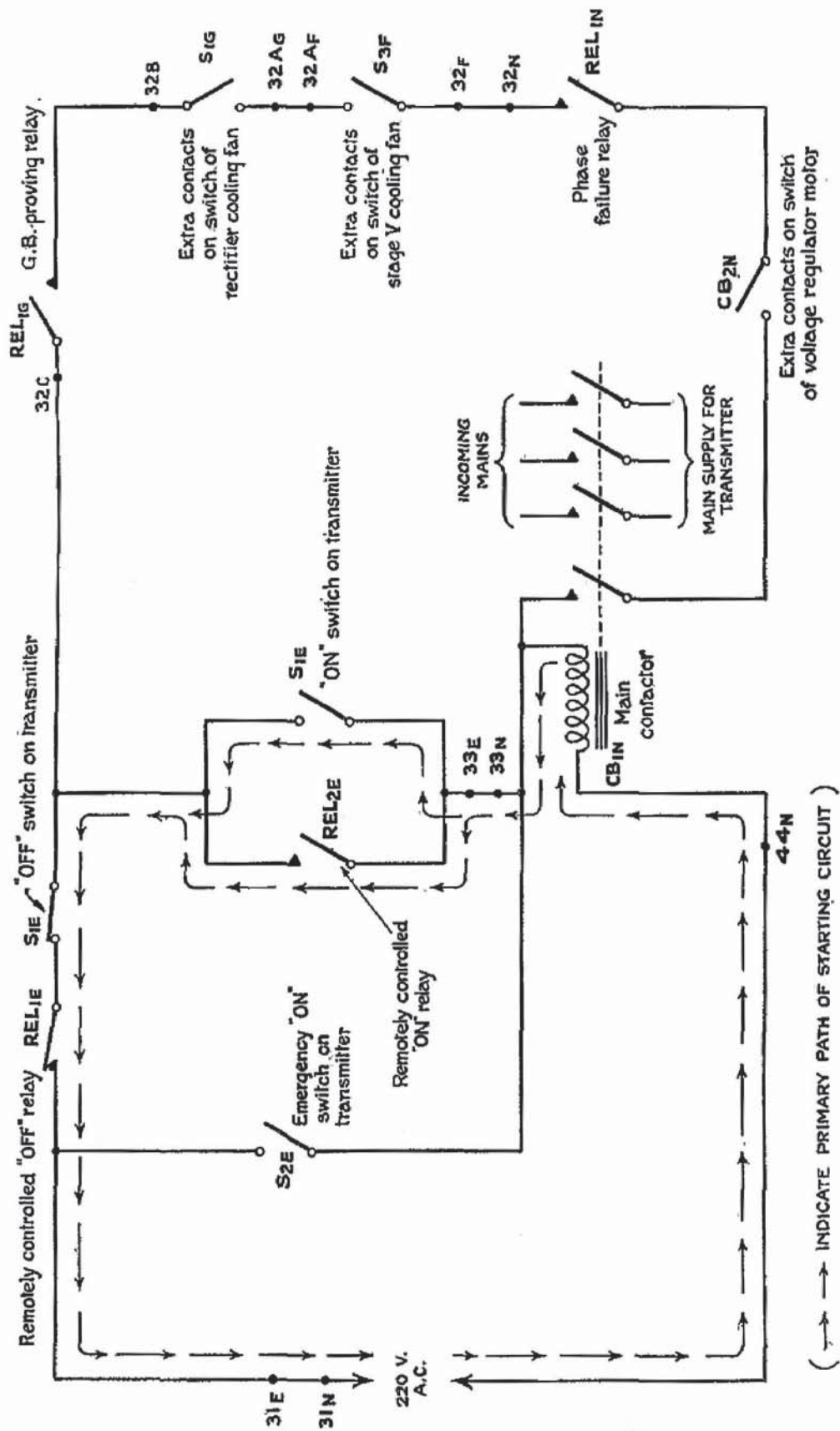


FIG. 8.—T1122, simplified starting circuits.

41. The starting circuit may be broken, and the transmitter stopped by momentary setting of either the switch S_{1R} or the relay REL_{1R} to the "off" position, which operations interrupt the holding circuit of the contactor CB_{1N} . Again, the starting circuit can be left permanently closed by keeping the emergency switch S_{2E} operated. As this measure cuts out all the protective devices, however, it should only be used when unavoidable, and far greater care taken that all temporary measures to keep the transmitter in working order are supervised.

42. Referring to fig. 7, the switchboard, section M, is connected to the three-phase mains at terminals A, B and C and the neutral at terminal N, and supplies the transmitter *via* the switch S_{2N} and the terminals R, S and T. The voltmeter M_{1N} is adapted to read the voltages across any of the A.C. lines by means of the switch S_{4N} . The switchboard also includes the main transmitter hut lamp, which is connected between one phase and neutral *via* the switch S_{3N} and the fuse F_{4N} . Heater terminals are also connected between the other phases and the neutral and are protected by the fuses F_{2N} . A three-pin socket for an inspection lamp is supplied *via* the fuse F_{3N} .

Marker beacons.

43. The theoretical circuit diagram of a marker beacon is given in fig. 9, the suffix letter employed being R. The transmitter is divided structurally into four units. The first is the R.F. modulator, which is used to adjust the frequency of the transmitter, the second, the oscillator amplifier, consists of a crystal-controlled oscillator valve, a mixer valve, and a push-pull output stage. The third unit is the A.F. modulator, and the fourth the supply unit.

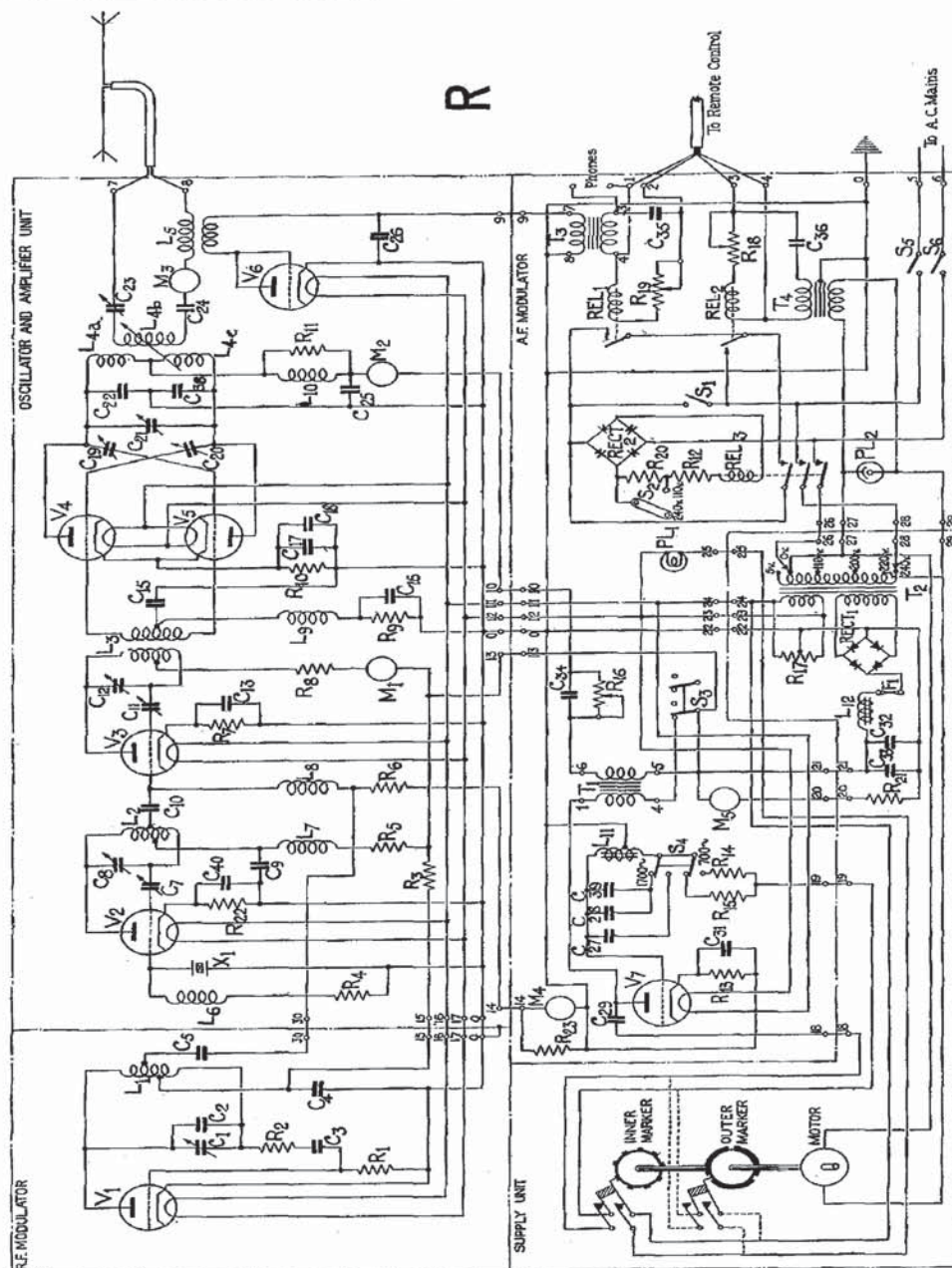
44. The R.F. modulator, stage 2, comprises the grid-stabilised Hartley oscillator valve V_{1R} , whose oscillatory circuit consists of the inductance L_{1R} which is tuned by the condenser C_{1R} with the condenser C_{2R} connected in parallel. One end of the inductance is connected to the anode of the valve V_{1R} and the other to the grid *via* the stopper resistance R_{2R} and the grid condenser C_{3R} . Grid bias is provided by the grid leak R_{1R} . The H.T. supply is fed *via* terminal 15 through the resistance R_{3R} to a tapping at the electrical centre of the inductance L_{1R} , which is maintained at earth R.F. potential by the condenser C_{4R} . By means of the tuning condenser C_{1R} fine adjustments may be made to the tuning of the stage, which has a frequency range between 2,150 and 2,250 kc/s.

45. The crystal X_{1R} forms the grid cathode circuit of the oscillator valve V_{2R} . It is shunted by the choke L_{6R} in series with the grid bias resistance R_{4R} . Grid bias is also partly provided by the cathode resistance R_{22R} , which is by-passed by the condenser C_{40R} . The heater of the valve V_{2R} , in common with the heaters of all the other valves in the transmitter, is supplied with low voltage A.C. through terminals 16 and 17. The anode circuit of the crystal stage consists of the inductance L_{2R} which is tuned by the condenser C_{8R} , and coupled to the grid through the feedback-control condenser C_{7R} . The H.T. supply to the anode of the valve V_{2R} is obtained from terminal 13, *via* the resistance R_{5R} , the choke L_{7R} and a tapping on L_{2R} which is by-passed to earth by the condenser C_{9R} .

46. A portion of the R.F. voltage set up across the inductance L_{1R} by the valve V_{1R} is applied through the condenser C_{5R} to the resistance R_{6R} , and similarly the signal voltage and the valve V_{2R} is applied to the grid of the mixer valve V_{3R} and the choke L_{8R} through the condenser C_{10R} . The combined voltage is applied to the grid-cathode circuit of the mixer valve V_{3R} , the return being *via* the terminal 14, the grid current meter M_{4R} and its shunt resistance R_{23R} . Grid bias is provided by the cathode resistance R_{7R} which is by-passed by the condenser C_{13R} .

47. The anode circuit of this valve consists of the primary of the R.F. transformer L_{3R} , which is tuned to the higher beat frequency of the mixed input by the condenser C_{12R} . Neutralisation is effected by the condenser C_{11R} , and H.T. is supplied from terminal 11 *via* the ammeter M_{1R} and the resistance R_{8R} . The untuned secondary winding of L_{3R} drives the grids of the push-pull amplifier valves V_{4R} and V_{5R} , of stage 4. The grid return circuit from the centre tap is connected to earth through the choke L_{9R} , which is by-passed by the condenser C_{15R} , and through the bias resistance R_{9R} , which is by-passed by the condenser C_{16R} . Additional grid bias is provided by the cathode bias resistance R_{10R} , shunted by the condensers C_{17R} and C_{18R} .

48. The anode circuit of the valves V_{4R} and V_{5R} consists of the balanced coils *a* and *b* of the inductance L_{4R} tuned by the variable condenser C_{21R} , and centre pointed to earth by the condensers C_{22R} and C_{38R} in series. The stage is neutralised by the condensers C_{19R} and C_{20R} . The valves are subjected to anode modulation, the H.T. supply proceeding from the terminal 21 to the supply unit through the secondary winding of the modulation transformer T_{1R} , thence through

[illegible]

T.1123, THEORETICAL CIRCUIT DIAGRAM.

FIG. 9

the voltage adjustment resistance R_{16R} , by-passed by the condenser C_{34R} to terminal 10 of the A.F. modulator. From terminal 10 of the oscillator amplifier unit it passes through the anode current meter M_{9R} and a filter consisting of the choke L_{10R} , with the resistance R_{11R} in parallel, to the centre of the R.F. transformer T_{1R} . The condenser C_{25R} excludes R.F. currents from the meter. Adjustable coupling between stage 4 and the aerial is provided by the coil b of the inductance L_{4R} . This is tuned by the condenser C_{23R} and feeds the dipole aerial, connected to terminals 7 and 8 through the condenser C_{24R} , the aerial ammeter M_{3R} and the primary winding of the R.F. transformer L_{5R} . The secondary winding of this transformer applies an R.F. voltage to the valve V_{6R} whose grid and anode are connected together so that it operates as a diode rectifier. The rectified voltage, whose R/F component is by-passed by the condenser C_{26R} , is applied to the primary winding of the transformer T_{3R} and is used to indicate the proper working of the transmitter.

49. The A.F. modulator valve V_{7R} is a triode oscillator connected in a modified Hartley circuit. One end of the choke L_{11R} is connected to the grid, the other is connected through one of the feedback resistances R_{14R} or R_{15R} , the keying circuit terminals 19 and 18, and the coupling condenser C_{29R} , to the anode. The switch S_{4R} selects the tuning condensers C_{28R} and C_{39R} for 700 c/s operation, or the condenser C_{27R} for 1,700 c/s operation, and also selects the appropriate feedback resistance. The feedback resistances are designed to produce equal A.F. voltages at either frequency. The anode load of the valve consists of the primary of the modulation transformer T_{1R} , which is connected to the H.T. supply at terminal 21 through the switch S_{3R} , which is used to cut off the H.T. from the valve during tuning operations, and is designated NORMAL TUNING.

50. The A.F. modulator section also includes the H.T. voltmeter, M_{5R} , and the keying indication lamp PL_{1R} , which is connected across terminals 23 and 25 of the supply unit, and is in series with one pair of keying contacts. The mains are connected to terminals 5 and 6, the overload release switches S_{5R} and S_{6R} being provided as isolators. To switch on the transmitter locally, the switch S_{1R} is closed. This applies the mains A.C. supply to the rectifier $RECT_{2R}$, the output from which energises the relay REL_{3R} via the resistance R_{12R} alone for 110-volt supply, or via the resistances R_{12R} and R_{20R} if the mains voltage lies between 200 and 240 volts, when the switch S_{2R} should be open.

51. When the transmitter is switched on from the remote control, direct current is sent over two of the connecting lines to terminals 1 and 2 and operates the starting relay REL_{1R} via the resistance R_{19R} . The mains are then applied to the rectifier $RECT_{3R}$ through the formerly closed contacts of the relay REL_{2R} and the contacts of the starting relay REL_{1R} . Two of the sets of contacts on the relay REL_{3R} then connect the mains through the terminals 26 and 28 to the primary winding of the mains transformer T_{2R} ; the third set are holding contacts which continue to supply the rectifier $RECT_{2R}$ with mains power when the starting relay REL_{1R} has released. The stopping relay REL_{2R} , which may be energised from the remote control via terminals 3 and 4, disconnects the mains supply from the rectifier $RECT_{2R}$ and so switches off the transmitter. When the transmitter is started locally by means of the switch S_{1R} , it is switched off when desired by opening the same switch.

52. The terminals 27 and 29, which supply the motor driving the keying system also excite the neon lamp PL_{2R} and the pilot lamp on the remote control unit, via terminals 3 and 4, the secondary of transformer T_{4R} and the condenser C_{36R} . The secondary winding of the monitoring transformer T_{3R} is connected to a telephone socket on the A.F. modulator panel, and also, through the condenser C_{35R} and terminals 1 and 2, to the remote control position.

53. The supply unit receives A.C. supply from the A.F. modulator unit through terminals 26 and 28 which are connected to tappings appropriate to the voltage on the primary of the mains transformer T_{3R} . The transformer also supplies the motor of the keying unit through terminals 27 and 28. There are two secondary windings; one of these supplies the heaters of the valves via terminals 23 and 24 and is centre pointed to earth by the potentiometer R_{17R} , the other secondary winding feeds the rectifier $RECT_{1R}$ whose negative terminal is earthed. The positive terminal of the rectifier is connected through the fuse F_{1R} and the smoothing choke L_{12R} to the anode circuits of the valves. The voltmeter resistance R_{21R} , connected to terminal 20, supplies the meter M_{5R} which indicates the H.T. voltage across the smoothing condensers C_{32R} and C_{33R} . Two keying wheels are driven through reduction gearing by the synchronous motor. In fig. 9 the contacts of the keying wheel for the inner marker are shown wired in circuit. For the outer

marker the four leads to these contacts are taken to the contacts of the other keying wheel as shown by the dotted lines. One pair of contacts is used to key the modulation; the other pair is connected in series with the pilot lamp PL_{2R} and the L.T. secondary of the mains transformer.

Remote control circuits

54. The remote control panel, section P; provides the means of controlling the whole of the blind approach system from a convenient position. Power for the remote control panel is provided by a separate supply unit, section 5. Theoretical circuit diagrams of sections P and S are shown in fig. 10.

55. The remote control supply unit may be fed from mains of voltages 105, 110 or between 200 and 245 volts, which are connected to terminals 1 and 2 and feed the transformer T_{1S} via the fuses F_{1S} , the switch S_{1S} and the chokes L_{2S} and L_{3S} , to which the by-pass condensers C_{1S} and C_{3S} are connected. The earth lead is attached to terminal O. Terminals 9 and 10, connected to the 220-volt tapplings of the primary winding of the transformer T_{1S} , provide an A.C. supply for the operation of the warning buzzer and light, and for the transformer T_{4P} in the remote control panel. The secondary winding of the transformer T_{1S} supplies the rectifier $RECT_{1S}$, whose 60-volt D.C. output is connected through the fuse F_{3S} to the load resistance R_{1S} and thence via the smoothing choke L_{1S} to terminal 5 and 6 across which is connected the smoothing condenser C_{3S} .

56. There are six control lines between the control panel and the main beacon transmitter, and four lines between the control panel and each marker beacon. All these lines are divided into pairs, each pair being used for two purposes. Direct current can be sent from the control panel along each pair to operate relays on the transmitters. Alternating current from the transmitters is carried by each pair to the control panel to indicate the correct operation of the transmitters. The D.C., which is momentary and the A.C., which flows the whole time the transmitters are working, are separated by filters and led to the correct components.

57. The six-pole, seven-position switch S_{1P} switches on the main beacon and two marker beacons when turned in a clockwise direction through its three positions. When it is returned to the central OFF position, these three transmitters are switched off. If reciprocal path marker beacons are installed, these can similarly be switched on and off, together with the main beacon, by operating the switch S_{1P} in a counter-clockwise direction. This operation also changes the main beacon keying from normal to reciprocal.

58. The operations performed by the six sections of S_{1P} are shown in simplified form in fig. 11. In the first position to the right, section 4 of the switch completes the circuit: + of 60 volts D.C., terminal 5 of control panel, link 3, the choke L_{10P} , terminal 20, terminal 20 of section E of main transmitter, the relay REL_{1E} , the resistance R_{1E} , terminal 21, terminal 21 of control panel, the choke L_{10P} , the indication meter M_{1P} , the choke L_{1P} , terminal 6, — of 60 volts D.C. The "off" relay REL_{1P} of the main transmitter, is therefore energised, and its contacts open. At the same time section 3 of the switch S_{1P} completes the circuit: + of 60 volts D.C., terminal 5 of control panel, the choke L_{8P} , terminal 4 (normal inner marker), terminal 4 of inner marker, the relay REL_{2R} , the resistance R_{18R} , terminal 3, terminal 3 (normal inner marker) of control panel, the choke L_{8P} , terminal 6, — of 60 volts D.C. The "off" relay REL_{2R} of the inner marker, is there energised, and its contacts open. Similarly the "off" relay of the outer marker will be energised via section 2 of the switch S_{1P} . In the second position to the right, sections 2, 3 and 4 of the switch S_{1P} complete the circuits of the "on" relays of the main beacon and marker beacons, via the chokes L_{11P} , L_{9P} , and L_{5P} . The three transmitters are thus brought into operation and the switch is moved to the third and normal operating position. In this position the sections 2, 3 and 4 connect the auxiliary "on-off" switches S_{3P} , S_{4P} , and S_{5P} to the + of the 60-volt D.C. supply. These switches enable any of the transmitters to be switched on and off independently. At the same time, section 6 of the switch S_{1P} connects the fault indicating circuits to the D.C. supply. The relay-operating current shown by the meter M_{1P} indicates that the connecting lines and relay coils are in order.

59. When the switch S_{1P} is moved to the left or "red" side, switch sections 2, 3 and 4 perform the same functions, but this time sections 2 and 3 control the reciprocal marker beacons if they are installed. Section 1 connects the relay REL_{1P} to the D.C. supply when the switch is moved to the left, thus changing over the indication system of the control panel for reciprocal path. In the second position to the left, switch section 6 energises the relay REL_{2D} of the main transmitter; thus operating the relay REL_{1D} which changes over the main beacon to dash keying. The function of section 6 in the third position to the left is the same as in the third

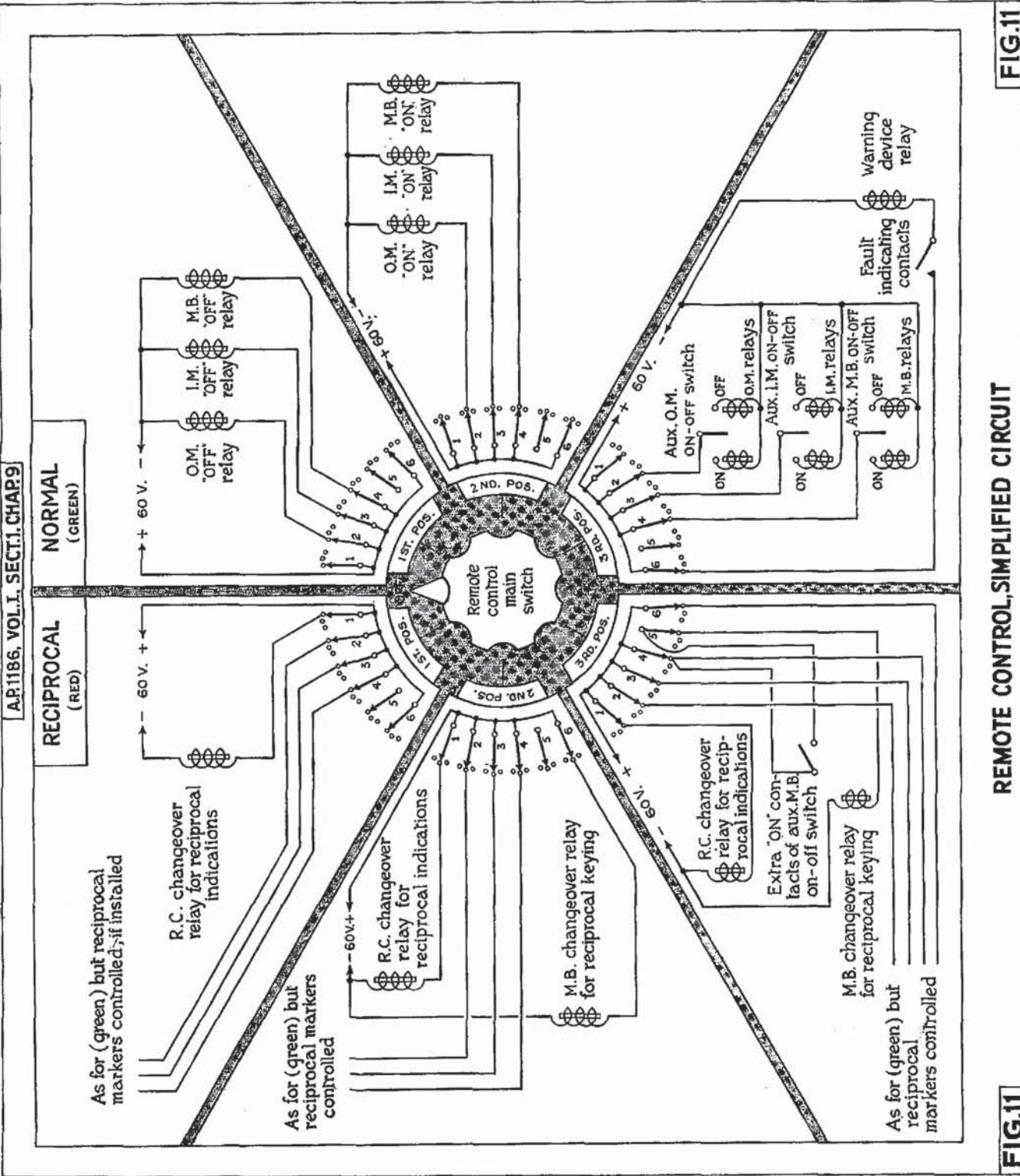


FIG.11

REMOTE CONTROL, SIMPLIFIED CIRCUIT

FIG.11

position to the right. If the main transmitter is now switched off for test purposes by means of the switch S_{5P} , the relay REL_{1P} will cease to be energised and its contacts will return to the normal keying position. Provision has therefore to be made for the relay REL_{2P} to be energised when the switch S_{5P} is moved to the ON position. This is achieved *via* the switch S_{6P} and section 5 of the switch S_{1P} when this latter switch is in the third position to the left.

60. Two forms of return indications are provided at the control panel from the main transmitter and from each marker transmitter. One shows that the mains are connected to the marker transmitter, and also, in the case of the main beacon, that the reflector aerial keying circuit is functioning correctly. The other indicates that the outputs of the transmitters are properly modulated, and in the case of the marker beacons, also indicates that keying is in operation.

61. The first indication is provided by the lamps PL_{1P} to PL_{6P} . These lamps are lit by current from the secondary winding of the transformer T_{4P} and controlled by the contacts of the relays REL_{8P} to REL_{13P} . When the mains are properly connected at the main transmitter, the keying motor will rotate and alternating voltages will be developed across the secondary windings of the transformer T_{3D} . One of these windings is connected across terminals 24 and 25, one end through the condenser C_{6D} and the contacts of the relay REL_{1D} , and the other *via* contacts of the relay REL_{3D} and another set of contacts of the relay REL_{1D} . Because the relay REL_{3D} is in the keying circuit, the A.C. passing along the leads from terminals 24 and 25 is interrupted in step with the keying. This keyed A.C., arriving at terminals 24 and 25 on the remote control panel, is blocked by choke L_{11P} , and so passes to the rectifier $RECT_{4P}$ through the condenser C_{8P} . The output from this rectifier causes the relay REL_{8P} to close and the lamp P_{1P} lights in accordance with the keying. When the relay REL_{1D} is energised to provide reciprocal keying, the keyed A.C. travels from terminals 26 and 27, and the lamp PL_{5P} is then illuminated in step with the reciprocal keying. The lamp PL_{1P} is coloured green and the lamp PL_{5P} is red. The condensers C_{8P} to C_{13P} prevent the D.C. for relay operation from reaching rectifiers $RECT_{4P}$ to $RECT_{9P}$.

62. When the mains are connected to the primary winding of the transformer T_{2R} in a marker beacon, the lamp PL_{2R} lights and A.C. is applied to the primary winding of the transformer T_{4R} . The output from the secondary winding of this transformer flows from terminal 4, and terminal 3 *via* the condenser C_{36R} , to the remote control panel. In the case of the normal inner marker the A.C. will be blocked by the choke L_{8P} and will travel to the rectifier $RECT_{8P}$ causing the green lamp PL_{3P} to light. Similarly, the green lamp PL_{2P} will be caused to light by the outer marker. The remaining two red lamps, PL_{6P} and PL_{6P} , are indicators for the reciprocal marker beacons.

63. Indication of the output of the main transmitter is obtained from the A.F. component of the output of the indicator unit J, which is conducted to the remote control unit from terminals 20 and 21 when the switch S_{4P} is set in the REMOTE position. From terminals 20 and 21 on the remote control panel this current reaches the primary winding of the transformer T_{1P} . The output of this transformer, and therefore the tone of the modulation, may be heard in telephones by placing the phone control switch S_{2P} in the appropriate position. A portion of the secondary winding of the transformer T_{1P} feeds the rectifier $RECT_{1P}$, whose output operates the relay REL_{14P} through the milliammeter M_{2P} . A reading on the milliammeter thus indicates that the output of the main beacon is being modulated. Should the modulation fail, the relay REL_{14P} releases, and contacts 1 and 2 will close. The closing of these contacts brings into operation a warning buzzer and a warning light PL_{7P} . A delayed action relay prevents the operation of the warning circuit until the delayed action H.T. switch in the main transmitter has had time to function.

64. The operation of the delay and of the warning circuit is as follows:—When the relay REL_{14P} is energised, its contacts 2 and 3 close. The coil of the relay REL_{1P} is thus connected across terminals 5 and 6 and the relay operates. Contacts 1 and 2 open, contacts 3 and 4 close and contacts 5 and 6 provide an alternative path for the energising current. When the relay REL_{14P} ceases to be energised, its contacts 1 and 2 short-circuit a portion of the winding of the relay REL_{1P} *via* the pairs of contacts 3 and 4, and 5 and 6 of the relay which also releases and its contacts 1 and 2 connect one end of the coil of the relay REL_{5P} to terminal 5 *via* contacts of section 6 of the switch S_{1P} . The other end of the coil of the relay REL_{5P} is joined to terminal 6

via the combined magnetic and thermal relay REL_{4P} after an initial delay of 40 seconds. One end of the magnet coil and one end of the thermal coil of the relay REL_{4P} are connected to terminal 5 by section 1 of the switch S_{1P} . The other end of the thermal coil is connected to terminal 6 by magnetic contacts 1 and 2.

65. The thermal relay commences to heat up and, after an interval, its contact 2 and 3 complete the connection of the magnetic coil across terminals 5 and 6. The magnetic contacts 5 and 6 close and maintain the magnetic coil circuit, while the circuit of the thermal coil is broken by the opening of magnetic contacts 1 and 2. The coil of the relay REL_{5P} is joined to terminal 6 by the magnetic contacts 3 and 4 and by the thermal contacts 1 and 2 of the relay REL_{4P} when the thermal relay has cooled and returned to its normal position. The cooling time required by the thermal relay ensures that the warning circuits will not become operative until after the main beacon has begun to radiate. The closing of contacts 1 and 2 of the relay due to the failure of the modulated output from the main beacon, energises the relay REL_{5P} . The warning buzzer across terminals 7 and 8 is, therefore, operated via one pair of contacts of the relay REL_{5P} and one pair of normally closed contacts of the relay REL_{6P} . At the same time the warning lamp PL_{7P} , fed from the 60-volt D.C. supply, has its circuit completed by one set of contacts of the relay REL_{5P} , one set of normally closed contacts of the relay REL_{6P} and the resistance R_{4P} . The switch S_{6P} permits the warning buzzer to be switched off until the fault is found and rectified, while leaving the lamp PL_{7P} lit.

66. When the switch S_{6P} is closed one section of the coil of the relay REL_{6P} is energised and its contacts in the buzzer circuit open. The contacts in the lamp circuit also open, but a new circuit for the lamp is made via a third lamp contact on the relay REL_{6P} and the second section of the coil of the relay REL_{6P} , which is thus held operated until the fault is cleared and the lamp contacts of the relay REL_{5P} open. When the switch S_{6P} is closed, one section of the coil of the relay REL_{6P} is in series with the alarm lamp PL_{7P} in the place of R_{4P} and the voltage across this lamp is maintained constant. The operation of the meters M_{3P} and M_{4P} via the transformers T_{2P} and T_{3P} is identical with that of the meter M_{2P} . The meter M_{3P} gives an indication of satisfactory modulation of the output of the outer marker and the meter M_{4P} of the inner marker. But because the modulation of the markers is keyed, the needles of the meters M_{3P} and M_{4P} will oscillate in rhythm with the keying. An absence of this oscillation would indicate that the keying was not functioning. The short circuiting of portions of the windings of the relays REL_{1P} , REL_{2P} , and REL_{3P} makes them slow to release, and prevents a fault alarm being given during momentary cessation of the operating current due to keying. The contacts of the relay REL_{7P} change over the primaries of the transformers T_{2P} and T_{3P} from the normal to the reciprocal marker connecting lines. Provision is made on the auxiliary on-off switches S_{3P} , S_{4P} and S_{5P} for short-circuiting the primaries of the transformers T_{1P} , T_{2P} and T_{3P} when the associated transmitter is switched off. This prevents any induced line voltages from giving an indication.

CONSTRUCTIONAL DETAILS

Main beacon

67. A front view of the main beacon transmitter type T.1122, is shown in fig. 12. The transmitter frame is mounted on a mild steel base incorporating rubber shock absorbers. Units A to H slide individually on runners into the framework, connections to these units being made by knife contacts which fit into spring contacts on the frame when the units are slid into position. Interconnections between the spring contacts are visible when the lower five covers on the back of the transmitter are unscrewed and removed. Behind the lower left-hand cover, looking at the transmitter from behind, are three terminal strips to which the external connections of the transmitter are made. These connections are for the voltage regulator, the reflector aerial relay boxes K and L and for the remote control and indication unit P. The indicator and aerial coupling unit J is fixed to one end of the transmitter frame, and to the coaxial cable (1) feeding the radiating aerial. The feeder is terminated by a special sealing end (2). Another special sealing end is also used where the feeder joins the aerial, particular attention being paid to the waterproofing of this termination when the equipment is installed.

68. The main transmitter power supply switch on the panel of section F is operated by a key handle (3). This key handle can be removed only when the switch is in the "off" position. It may then be used to unlock the three rear covers and the three false front panels of sections A, B and C, by insertion in the keyholes (4) and counter-clockwise rotation. The panels are allowed

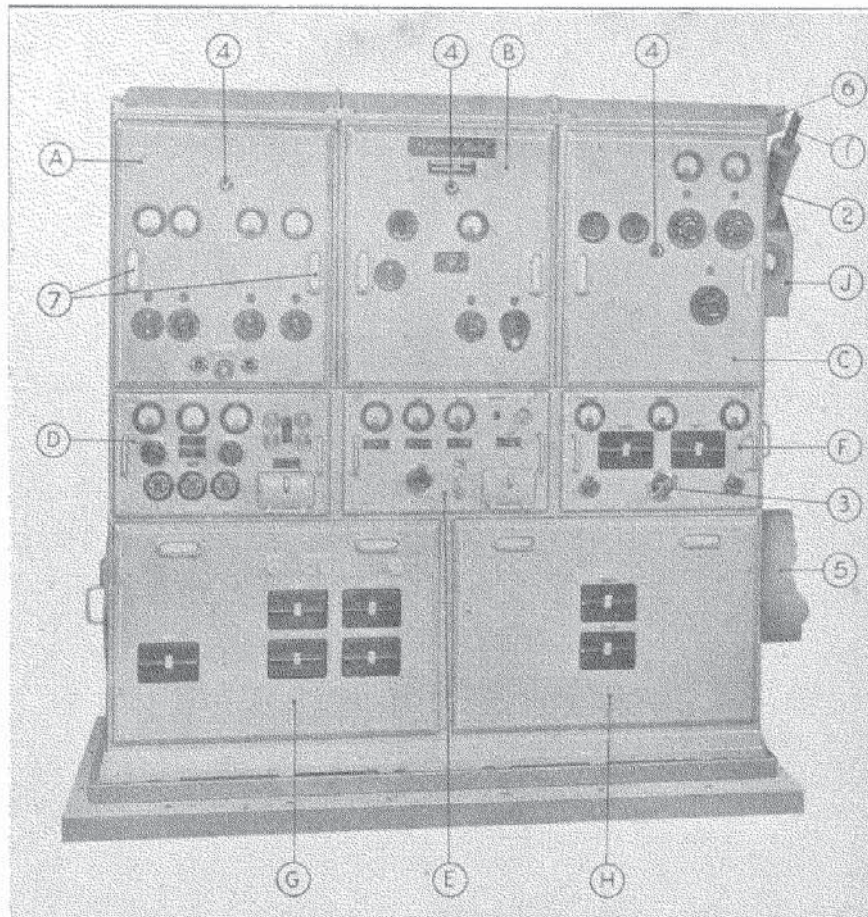


FIG. 12.—T. 1122, front view.

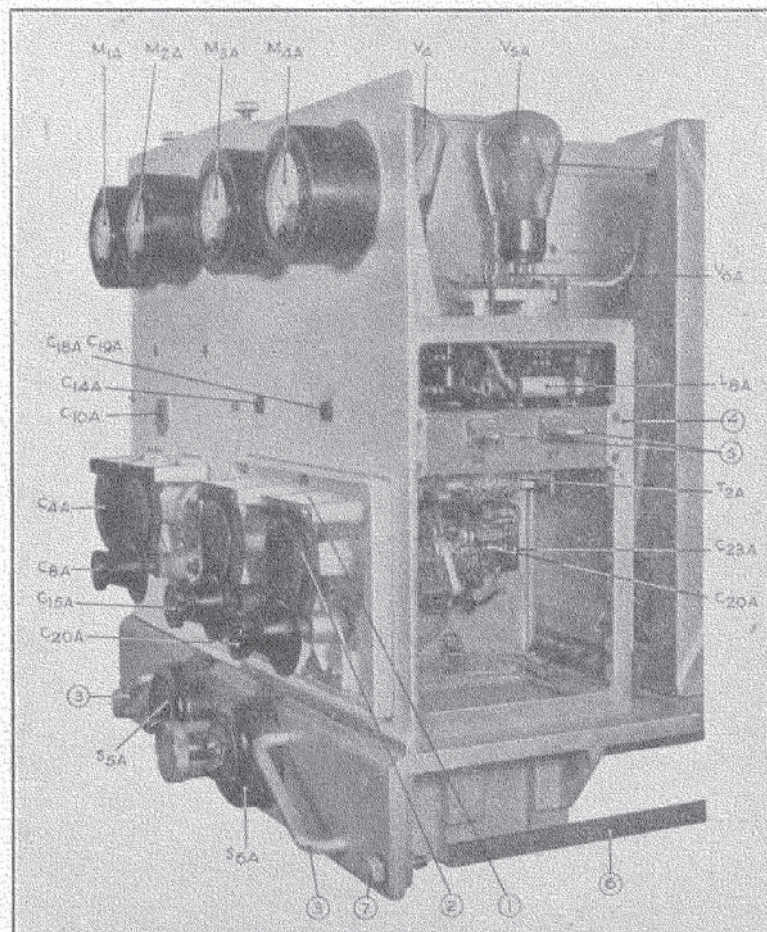


FIG. 13.—T. 1122, unit A, front view.

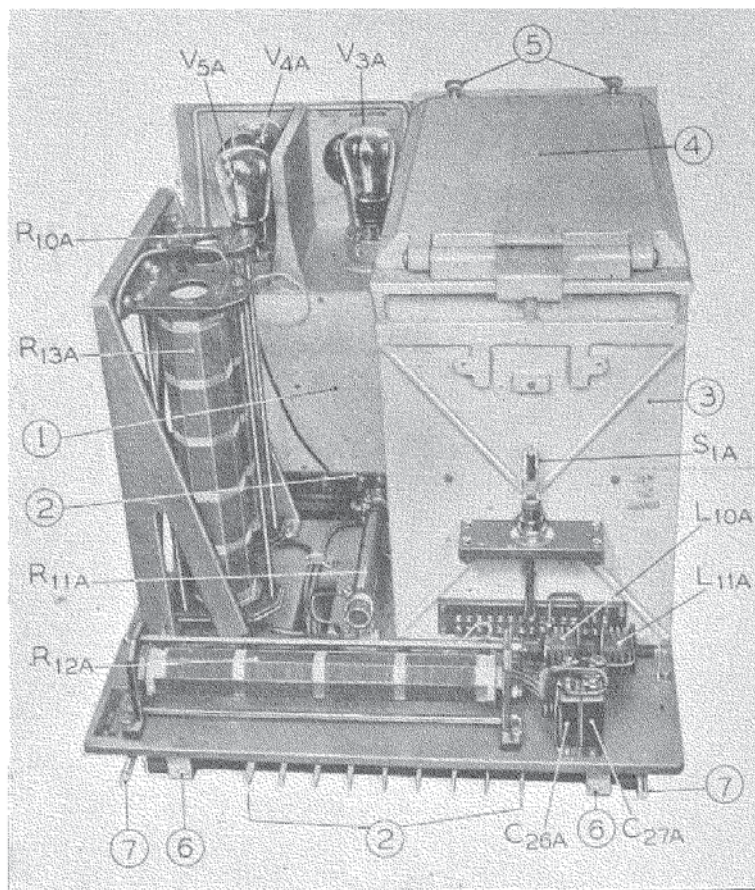


FIG. 14.—T. 1122, unit A, rear view.

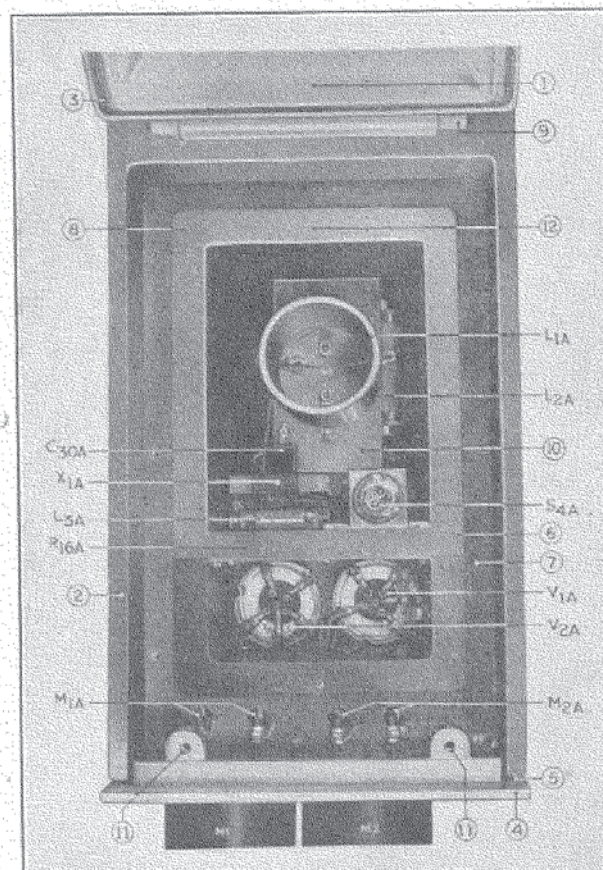
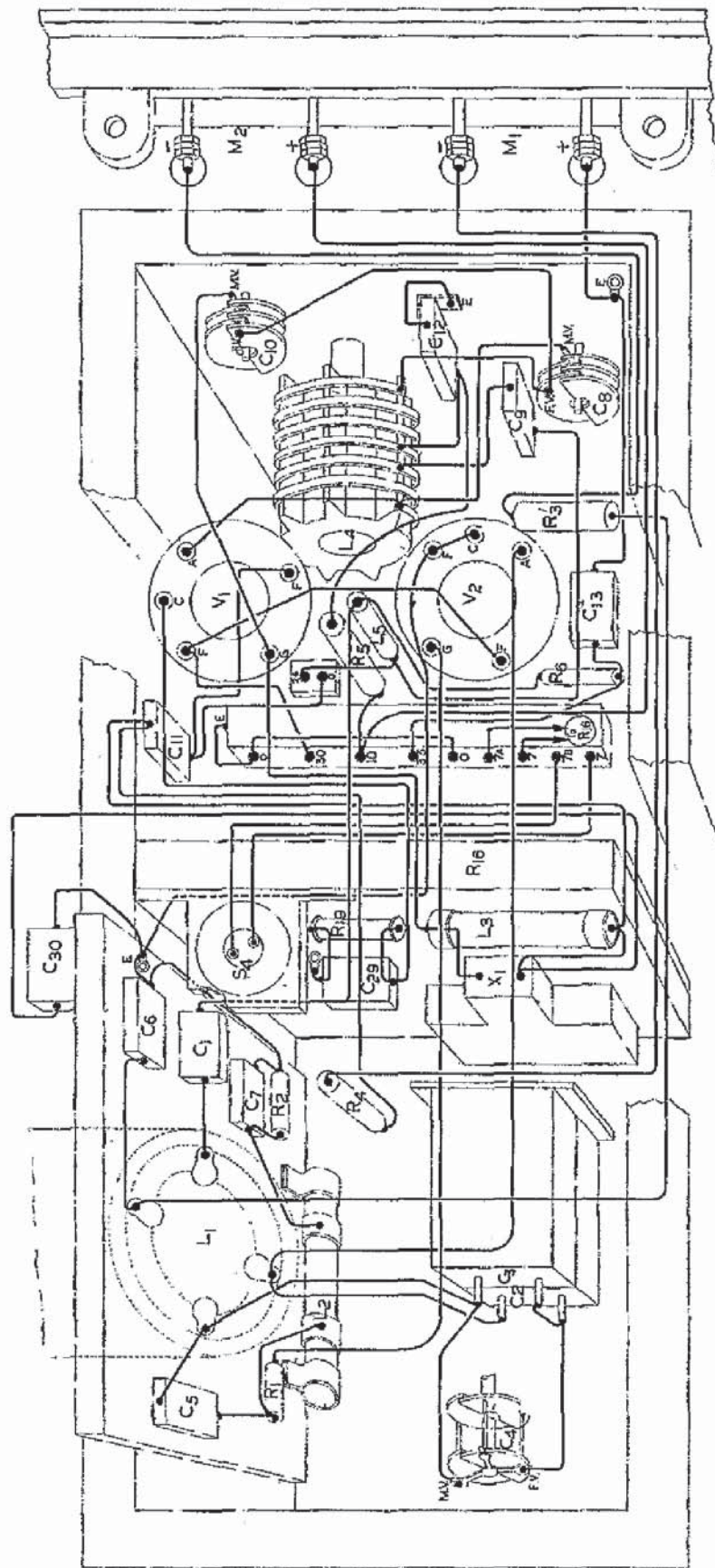


FIG. 15. —T. 1122, unit A, interior of oven.



T1122, UNIT A, MODULATOR AND STAGE 1, BENCH WIRING DIAGRAM

FIG. 16

FIG. 16

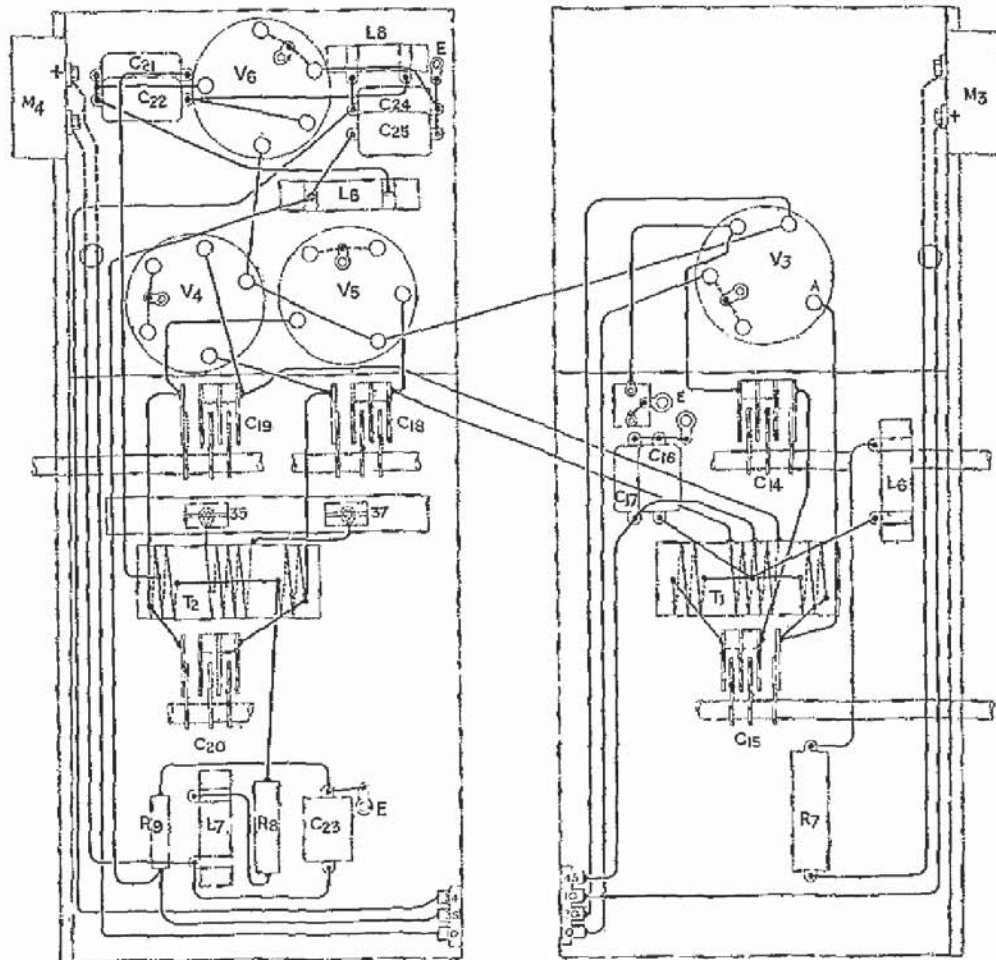


FIG. 17.—T. 1122, unit A, stages 2 and 3, bench wiring diagram.

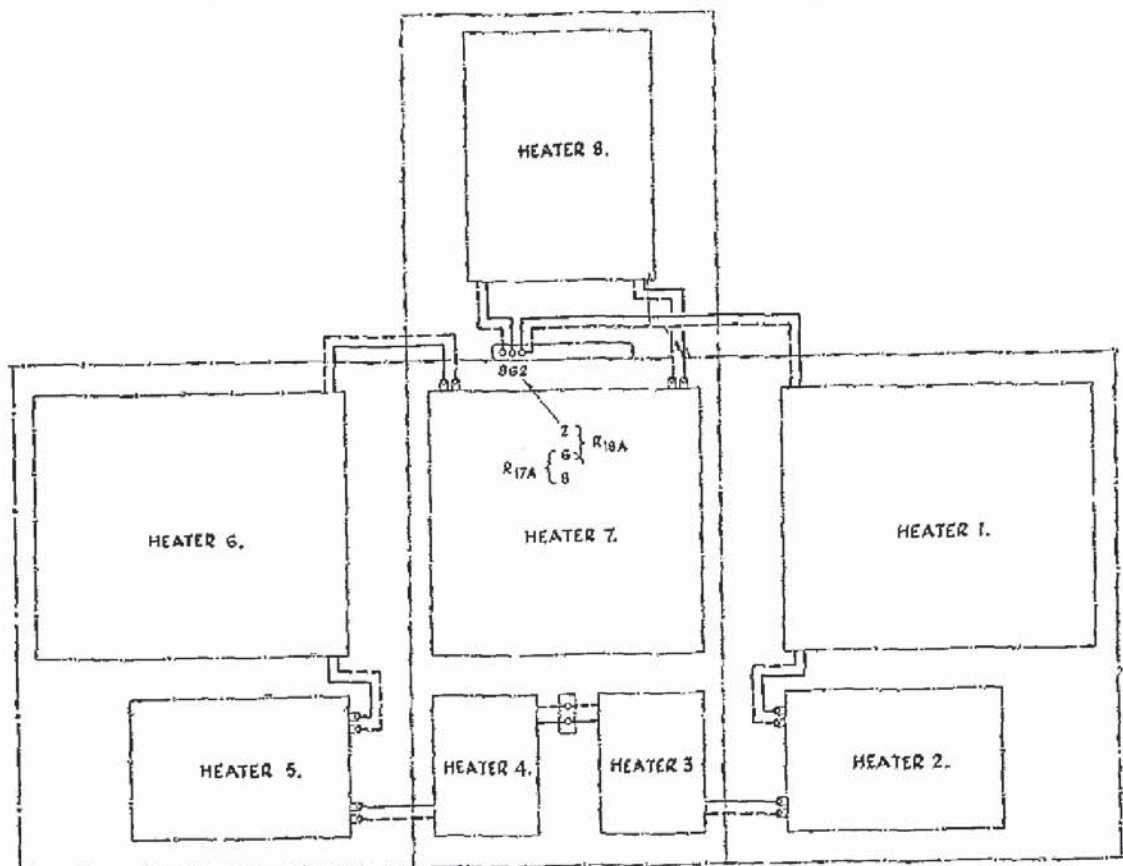


FIG. 18.—T. 1122, unit A, oven wiring.

to lean forward to clear projecting controls and meters, and then lifted out by means of the handles (7). Removal of these covers and false panels, which gives access to the R.F. components of the transmitter, can therefore normally be achieved only when the transmitter is switched off. The key cannot be withdrawn until the cover is again locked in position.

69. The cooling air for section C of the transmitter is sucked in by a fan in section F through a grill in the end of the transmitter frame. It rises through section C and is exhausted through the duct (6). Cooling air for the rectifiers in sections G and H is sucked in by a fan at one end of section G and passes out *via* the duct (5) below the section C air inlet. Sections D, E and F

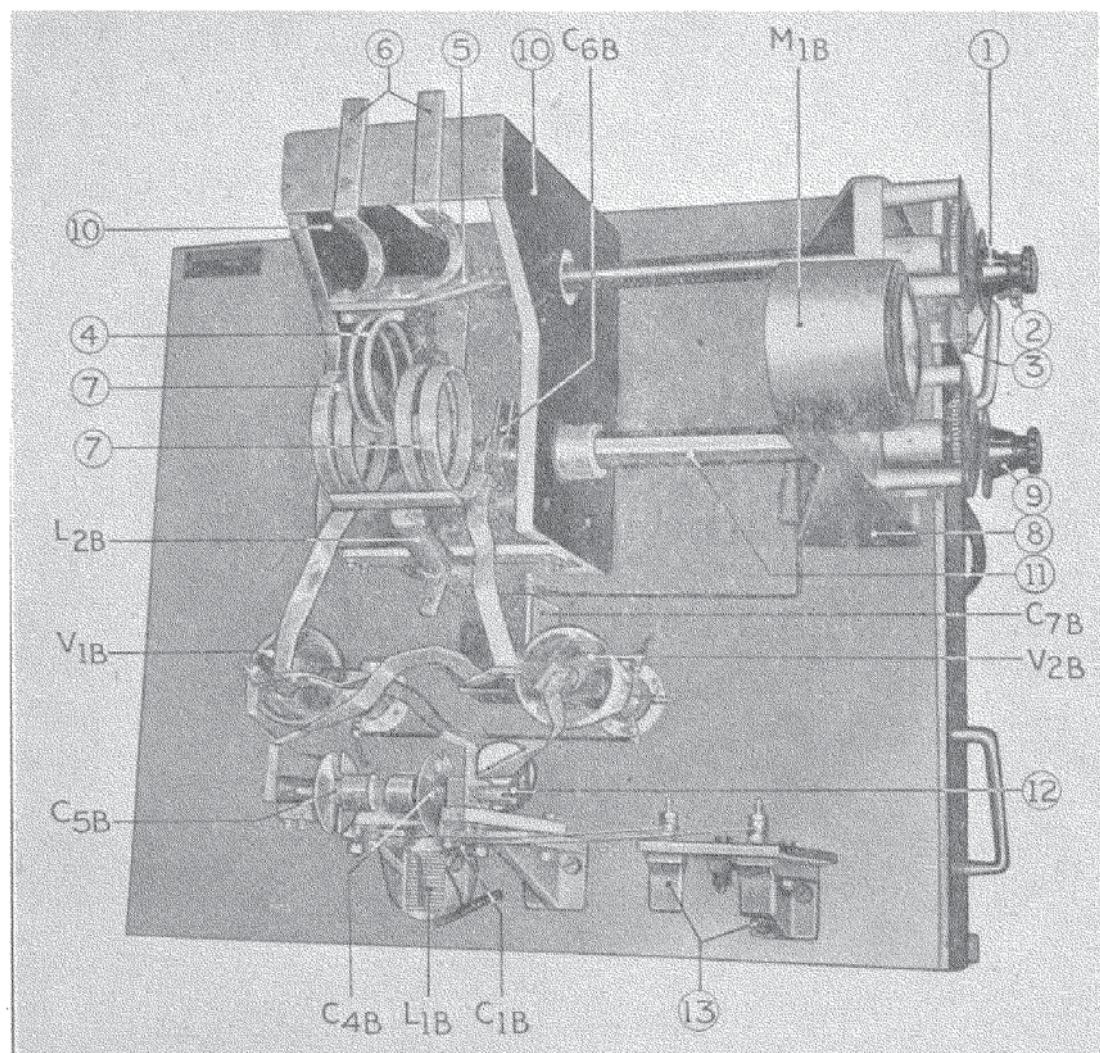


FIG. 20.—T. 1122, unit B, view of top side.

may be pulled out after slackening the captive retaining screws, and sections G and H may similarly be removed after slackening the captive retaining screws and removing the front panels.

70. A front view of section A, with the false panel removed, is given in fig. 13. Below the meters, on the left, is a cover protecting the entry of the special tool used to set the neutralising condenser C_{10A} . Further to the right are insulated rods with screwdriver slots used for adjusting the neutralising condenser C_{11A} and the ganged neutralising condensers C_{18A} and C_{19A} . These three controls are normally concealed by the false front panel. Below these are the slow motion controls and dials of the condensers C_{1A} , C_{8A} , C_{15A} and C_{20A} . The first of these is set by means of a key with reference to a calibration chart in accordance with the crystal used; the other three are fitted with geared tuning knobs. The hair lines carried on the pillars (1) and part of the

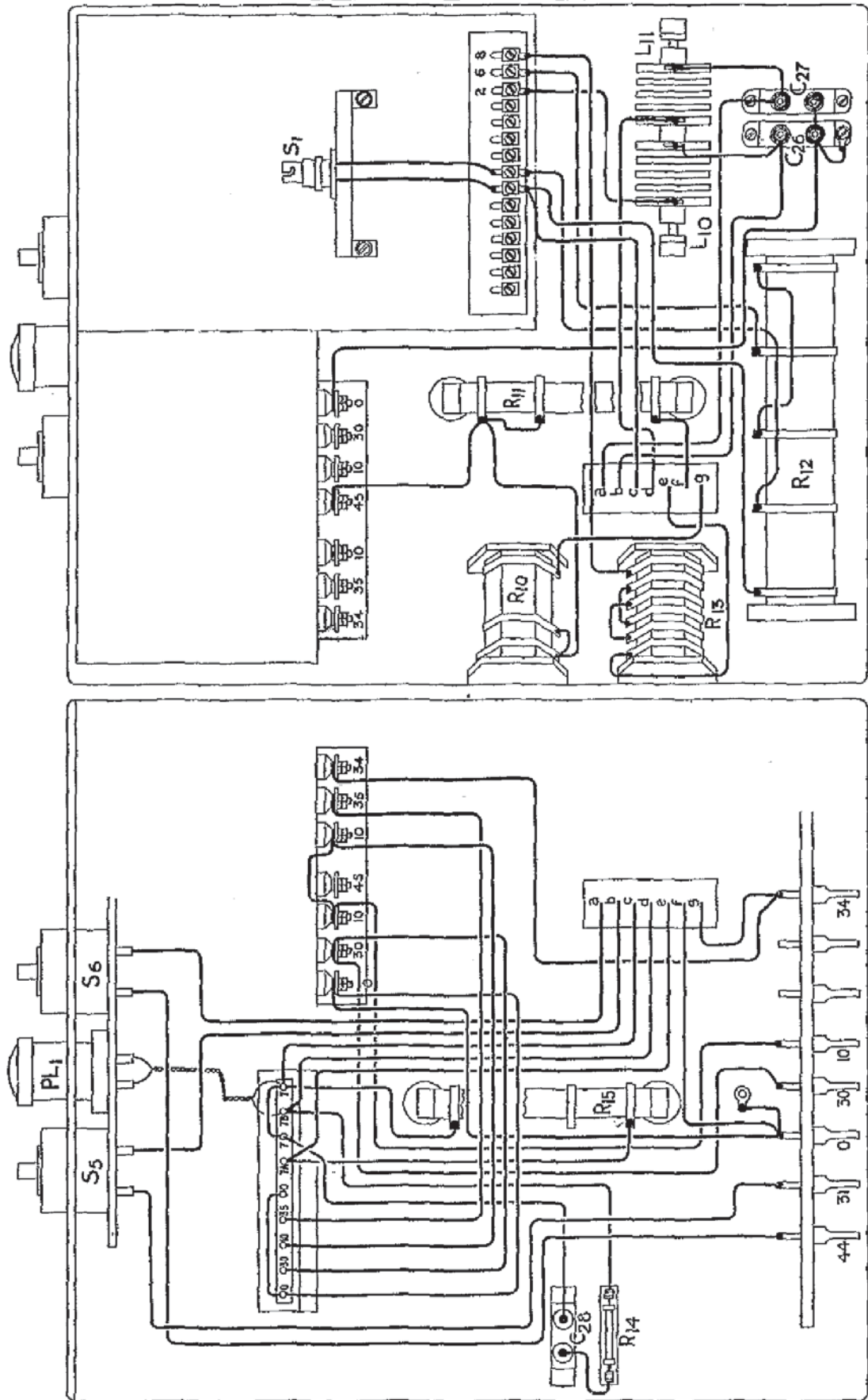


FIG. 19

FIG.19

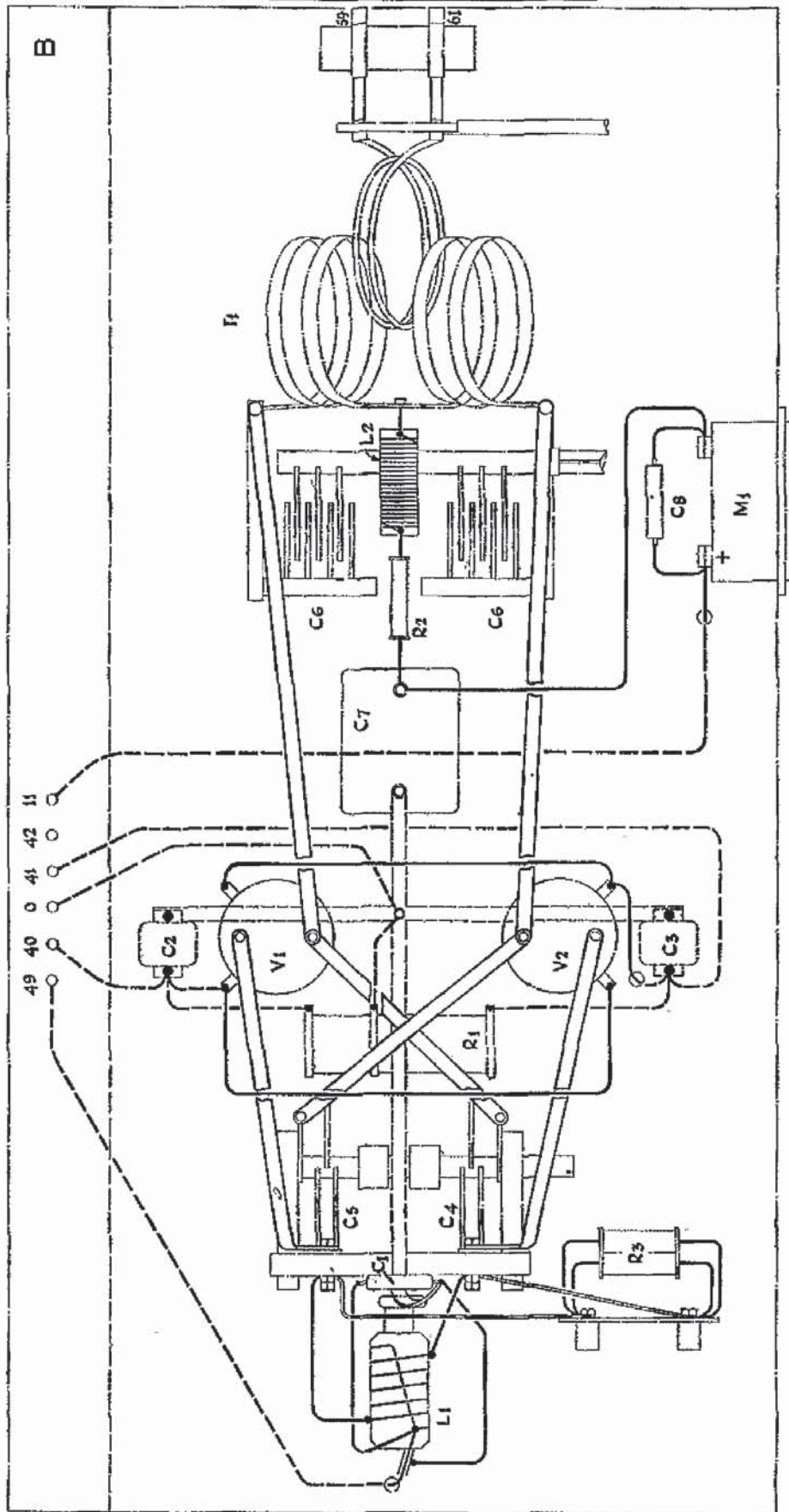


FIG. 21

T.1122, UNIT B, BENCH WIRING DIAGRAM

FIG.21

dials (2) are visible through apertures in the false front panels. The handles (3) are used for withdrawing the section from the housing.

71. On the right are seen the components of stage 3 of the transmitter. Below the valves V_{4A} and V_{5A} is the screened compartment (4) containing the R.F. circuits. The cover has been removed. The contacts (5) serve to contact stage 3 to stage 4. Below is one of the two runners (6) on which the unit slides on the transmitter framework, and to its left is one of the captive screws (7) used to lock the section in position.

72. The rear of unit A is shown in fig. 14. On the left are the components of stage 3, and in the centre is the valve, V_{3A} , of stage 2, whose remaining components are contained in the screened compartment (1) below it. Below the base panel and at the rear of the unit (2) are seen the contacts (2) through which the supplies are fed to the circuits. On the right is the oven (3) containing the crystal oscillator, stage 1, and the R.F. modulator. The hinged lid (4) of the oven is held down by captive screws (5). The runners (6) and the locating pins (7) serve to align the assembly in the main transmitter frame.

73. An interior view of the oven is given in fig. 15. The lid (1), which is hinged at (9) fits tightly on the flange (2) and is secured by screws at (11), is shown lifted, exposing the gasket (3). The front (4) of the oven is removable and is made airtight by a gasket (5). The oven contains an inner compartment (6) suspended on a platform (7). This compartment is further sub-divided by the partition containing the heating resistance R_{16A} . The mounting (10) containing the grid circuit components of the crystal oscillator and R.F. modulator valves is enclosed by a metal plate, not shown, which is retained by screws (8) on the flange (12). The space between this metal plate and the lid (1) is filled by a felt insulating pad. Bench wiring diagrams of section A are given in figs. 16, 17, 18 and 19. These comprise stage 1 and the R.F. modulator, stages 2 and 3, the oven heaters, and the general wiring interconnecting these units, respectively.

74. Unit B of the transmitter, which contains the components of stage 3, is illustrated in fig. 20 and a bench wiring diagram is given in fig. 21. The view is from above, the components on the right being those normally seen through apertures in the false front panel. The control (1) operates the anode coupling of stage 4, and may be locked by the knurled nut (2) which clamps the sector (3). The coupling coil (4), which is mounted on a mycalex lever (5) and is flexibly connected to the contacts (6) feeding the next stage, forms the secondary of the transformer T_{1B} , whose primary consists of the two coils (7). The meter M_{1B} is mounted on a long bracket (8) also carrying the controls; the condenser C_{8B} is mounted behind the meter. The slow motion control (9) operates the split stator condenser C_{4B} , mounted on the panels (10), through the control rod (11). The ganged neutralising condensers C_{4B} and C_{5B} are controlled by means of an insulated tool which is inserted through an aperture in the false front panel. This tool engages with the slot (12), and the contacts (13) connect the unit to section A. At the rear of the base panel are mounted spare coupling coils for stages 4 and 5, for use if the output frequency of the transmitter is to be altered. These are not shown in the illustration. A glazed opening in the false front panel permits inspection of the valves.

75. Unit C of the transmitter, which is illustrated in fig. 22, comprises a baseplate and fittings resembling those of unit B. The slow motion controls (1), (2) and (3) operate the aerial coupling, the tuning condenser C_{7C} , and the condenser C_{8C} respectively. The valves, one of which has been removed for illustrative purposes, are supported at the upper extremity by hinge locating levers (4) which may be clamped by the screws (5). The flexible anode and grid leads (6) are integral parts of the valve. Two windows in the front panel allow observation of the valves; that on the left is removable to give access to the neutralising condenser. A view of the aerial indicator and coupling unit J, which is fixed to the side of the transmitter housing, is given in fig. 23.

76. The modulating and keying unit, section D, is illustrated in fig. 24. The cast panel runners, locating pins and plug-in terminals resemble those of sections A, B and C. No false panel is fitted, the whole assembly being held in position by captive screws. The lamps and the switch S_{3D} are attached to the front panel by a separate sub-assembly (1). The synchronous motor (2) is coupled to the audio-frequency generator (3), which drives the four wheels (4) through reduction spur gearing. The components (2), (3) and (4) are carried on an independent mounting bolted to the base plate of section D. In some models of the transmitter these components are contained in a single housing. Keying wheel number 3 in the theoretical circuit diagram, fig. 3,

is at the end of the spindle ; then follow wheels 4, 1 and 2 in that order. Wheel number 2 is that normally used.

77. Bench wiring diagrams of units C and D of the main beacon transmitter are given in figs 25 and 26 respectively.

78. A view of the D.C. control unit, section E, is given in fig. 27. As regards the framework construction the unit is similar to section D. The aperture in the centre of the panel below the switch S_{3E} and the meter M_{3E} admits the removable knob used to adjust the potentiometer R_{3E} through the gear wheel (1) and an archimedean screw. The switch S_{3E} is normally retained in the OFF position by a locking plate held by four screws. A hinged door gives access to the relays REL_{2E} and REL_{1E} .

79. Unit F of the transmitter is built on a similar framework to that of units D and E. A view of the unit, taken from above, is shown in fig. 28, and a bench wiring diagram is given in fig. 30. The fan, whose cast aluminium framework is normally attached to the upper part of the unit, by screws and locating pins, is electrically connected through the contacts (1). The overload releases of the switches S_{3F} and S_{4F} are thermally controlled, and (2) indicates the thermal devices of S_{3F} the back cover of which has been removed. These switches, and also the seven similar components on the high voltage and low voltage rectifiers, function in the following manner. The magnet winding of the overload release mechanism is wound in two sections which are connected in series-opposition. These sections carry the current passing through the circuit breaker, but being wound in opposition, they do not magnetise the core. The current through the circuit breaker also passes through the thermal relay winding. When the current through the switch rises to an undesirable extent, the contacts of the thermal relay close and short circuit one section of the magnet winding. The other section of the winding, now no longer being opposed, magnetises the core and the release mechanism operates. Bench wiring diagrams of units E and F are given in figs. 29 and 30 respectively.

80. The low-tension rectifier unit, section G, is built up in five separate sections, mounted side by side on a cast base plate. A view of the unit is shown in fig. 31 ; the false front, which resembles that of sections A, B and C except for the absence of the locking device, has been removed for illustration purposes. The relays REL_{3G} , REL_{1G} and REL_{2G} , which are not shown in the illustration, are mounted vertically below REL_{2G} and behind the switch S_{1G} , under a removable dust cover. The fan (1) which cools the rectifiers is fitted with a lubrication pipe (2). The cover of the switch S_{1G} has been removed to display the mechanism.

81. The terminal board (3) of the transformer T_{1G} has the secondary transformer tapplings arranged for simple voltage adjustments by means of movable links. The upper three terminals A_2 , B_2 and C_2 are connected to the regulated 220-volt supply. Below these are three further terminals a_0 , b_0 and c_0 each of which is surrounded by four terminals, numbered 1, 2, 3 and 4 arranged in the arcs of circles. Below these again are similar arrangements with terminals a, b and c as centres, each surrounded by four terminals numbered 5, 6, 7 and 8. Links mounted on terminals a_0 , b_0 , c_0 and a, b and c can be moved around to connect with any one of the four surrounding numbered terminals.

82. A front view of the H.T. rectifier unit H is given in fig. 32. The 1,500-volt circuits are mounted on a casting (1) which is extended to support the overload release switches S_{1H} and S_{2H} which project through the false front. The casting also supports the girder structure (2) mounting the components of the 2,500-volt circuit. The terminal board (3) of the transformer T_{2H} enables voltage adjustments to be made by reconnecting either of the two sets of primary leads. Bench wiring diagrams of units G and H are given in figs. 33 and 34.

83. A view of the switchboard panel, section M, is given in fig. 35, and a bench wiring diagram in fig. 36. Below each of the fuses, which are annotated in accordance with the theoretical circuit diagram, are mounted spare fuses. Along the bottom of the panel of the switchboard is a strip (1), separate from the main part of the panel. When this strip, which is held by two domed nuts (2), is removed, access is obtained to the terminals of the switchboard. At (3) is seen a plug and socket for fitting an inspection lamp. The lamp (4) gives general illumination to the transmitter hut.

84. *Voltage regulator.*—An external view of the voltage regulator unit N is given in fig. 37, showing the general layout of the principal components and controls. Enlarged views of the upper and lower assemblies, with the dust covers removed, are given in figs. 38 and 39, and a

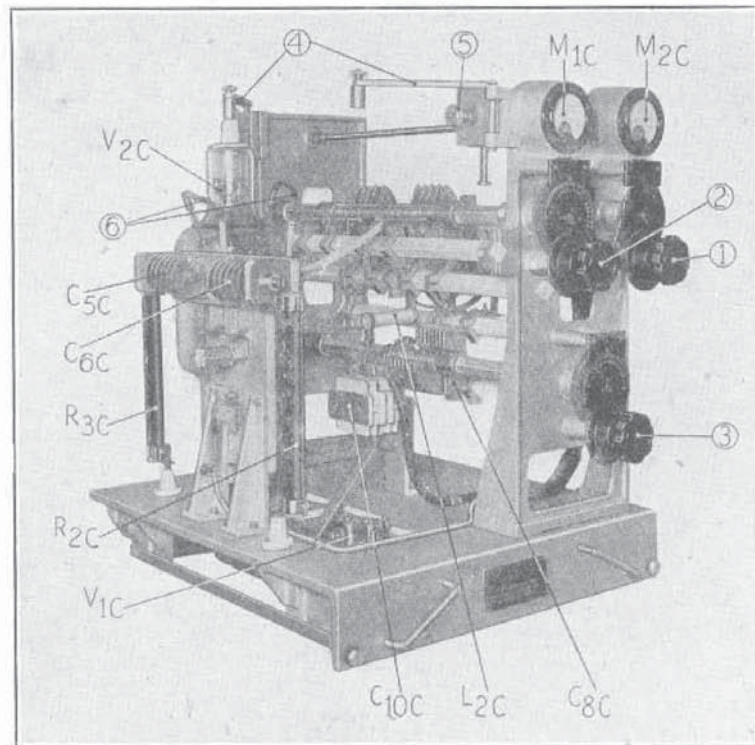


FIG. 22.—T. 1122, unit C, front view.

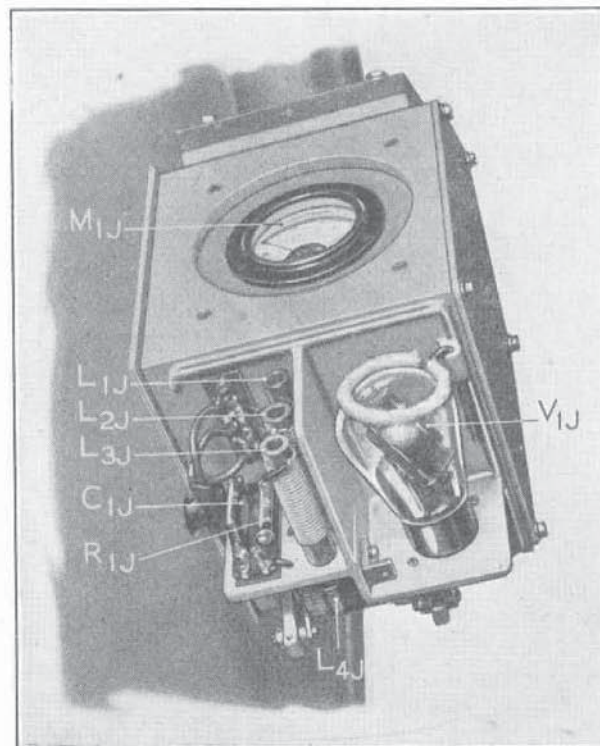


FIG. 23.—T. 1122, unit J, underside view.

bench wiring diagram in fig. 40. The unit illustrated in fig. 37 differs slightly in design from that shown in figs. 38 and 39, and is representative of later models of the equipment.

85. Referring to fig. 38, at (1) is seen the terminal board of the induction regulator REG_{1N} . This regulator is driven by the servo motor regulator REG_{2N} , which is fitted with an adjusting screw (2) and an on-off control (4). The filler plug (3) and window (5) enable the oil level to be adjusted and checked. The motive power of the regulators REG_{1N} and REG_{2N} is supplied by the electric motor (6). These components are mounted above the switchgear unit which is

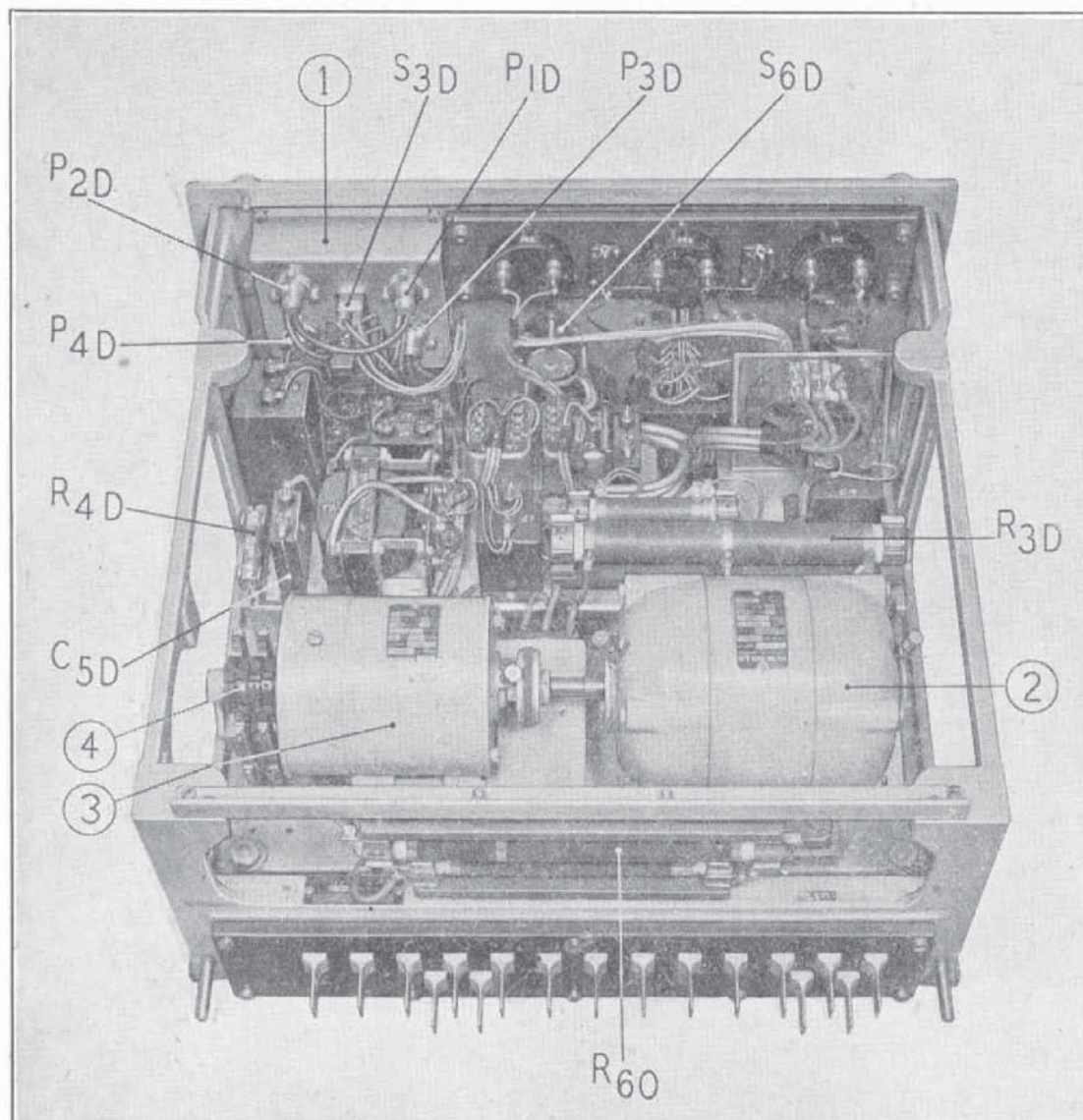


FIG. 24.—T. 1122, unit D, view of topside.

illustrated in fig. 39, in which the bevel gearing connecting the servo regulator and the induction regulator is seen at (1) and a can of oil, for replenishing the servo motor, at (2).

86. The action of the oil system of the servo motor is illustrated diagrammatically in fig. 41. The oil normally circulates through the oil pump from the sump (1) into the pipe (2) thence through the safety valve, which is controlled by the spring (3), through the pipe (4), through the hollow piston rod and out of the aperture (5). After filling the reservoirs (6) and the chamber (7), the surplus oil overflows back into the sump. A weir (8) admits the oil from the reservoir (6) into the chamber (7). The oil pump is continuously rotated by the electric driving motor. This state of affairs obtains only so long as the pilot sleeve is in its normal position, the aperture (5) being about half-open. The pilot sleeve, which slides over the piston rod, is under the control

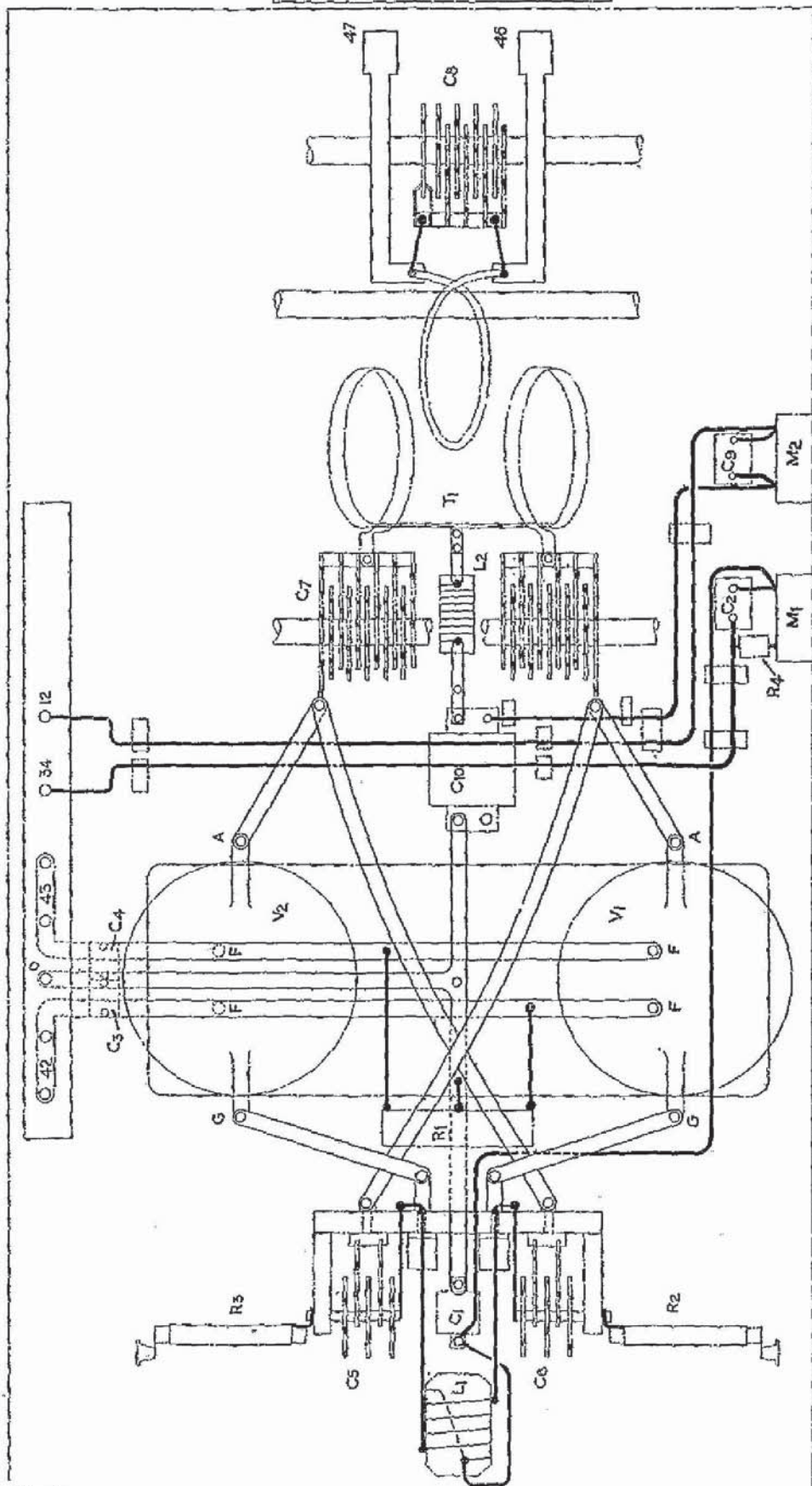
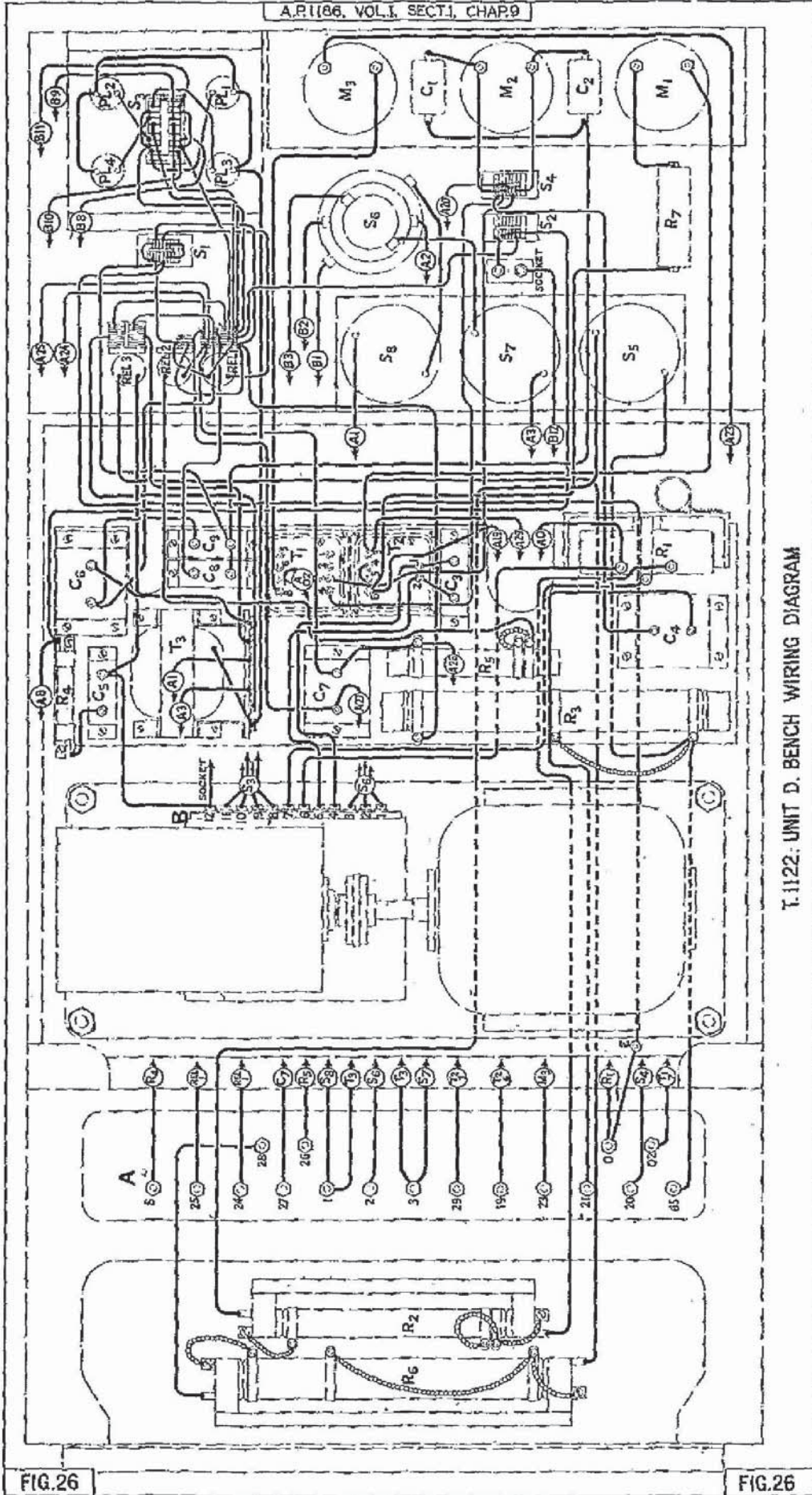


FIG. 25

FIG. 25



T. 1122: UNIT D. BENCH WIRING DIAGRAM

of the line voltage, being attached to the armature of the potential coil connected across one phase of the mains. The piston is continuously rotated at a low speed by a worm wheel drive from the oil pump.

87. If the line voltage falls, the armature will drop, covering the aperture (5), thus increasing the oil pressure above the safety valve, which is therefore momentarily closed, and the oil is forced into the chamber above the differential piston, which is forced downwards, allowing oil to flow from the pump, through the pipes (9) and (10) into the right-hand chamber of the servo motor. This forces the servo motor spindle to rotate clockwise, displacing oil through the

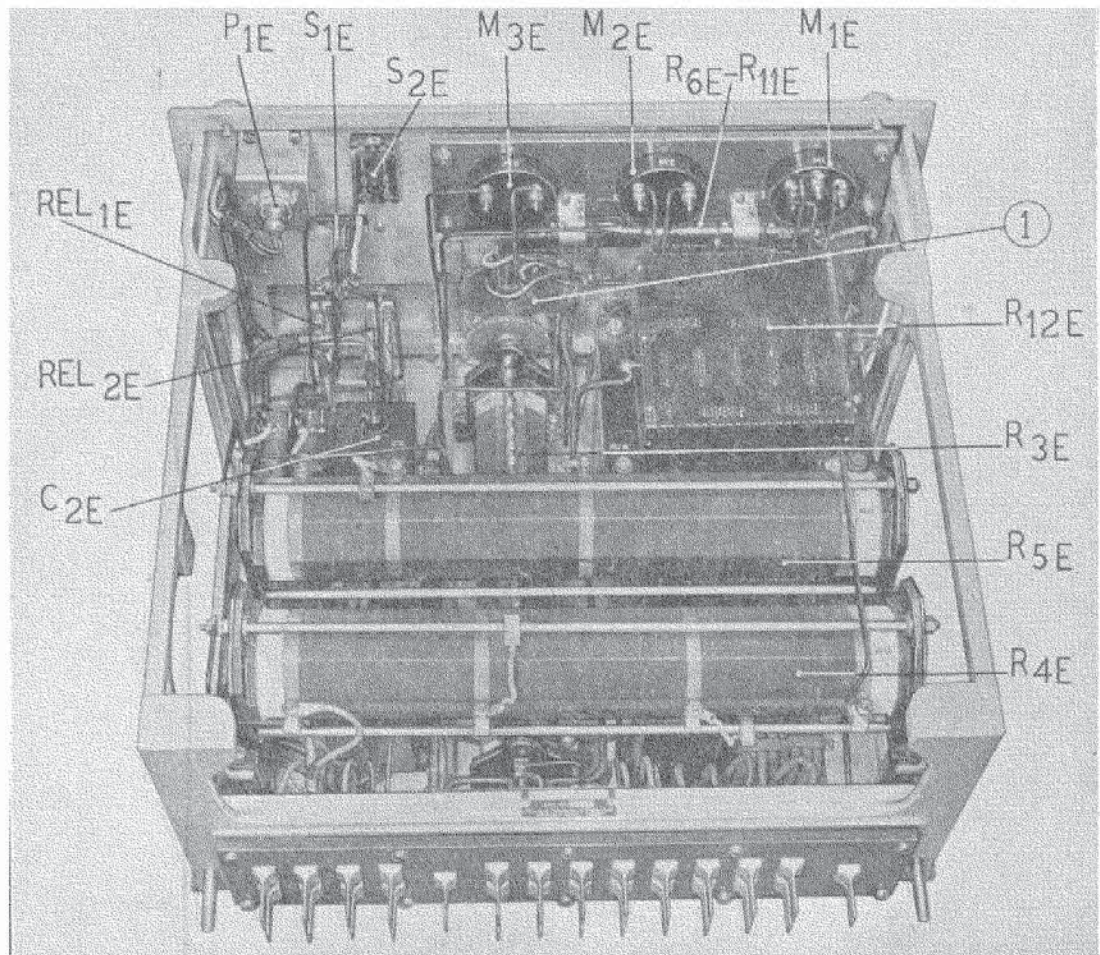


FIG. 27.—T. 1122, unit E, topside view.

pipes (11) and (12) into the reservoir (6) through the aperture (5) which is reopened by the depression of the piston. The servo motor spindle is mechanically coupled to the spiral cam, and the clockwise rotation therefore lifts the plunger (13) against the pressure of the spring (14), thus increasing the oil pressure in the chamber (15). This momentarily lifts the piston (16) against the pressure of the spring (17) which raises the pilot sleeve through the bar (18), and decreases the oil pressure above the safety valve allowing the differential piston to rise, thus reversing the oil flow through the servo motor system, and allowing the spindle to return to its normal position. Meanwhile, the oil in the chamber (15) is allowed to leak through the needle valve (19), and this checks the continual oscillation of the armature, and therefore of the output voltage, which would otherwise ensue. The rate of oil leakage is adjustable by the check screw which controls the needle valve (19), and which is fixed in the predetermined position by the lock nut (20).

88. If the mains voltage should rise, the operation cycle would be reversed, starting with oil flow through the pipes (12) and (11) into the left-hand compartment of the servo motor and out of the right-hand compartment *via* the pipes (10) and (9). The screws (21) and (22) may be interchanged in position, if the design of the induction regulator demands clockwise rotation for *reduction* of voltage instead of that assumed in the preceding paragraphs. This interchange connects the pipes (9) and (12) to the pipes (11) and (10) respectively, and necessitates the reversal of the spiral cam on its spindle.

89. The aerial system of the main beacon transmitter is shown in fig. 42 which shows

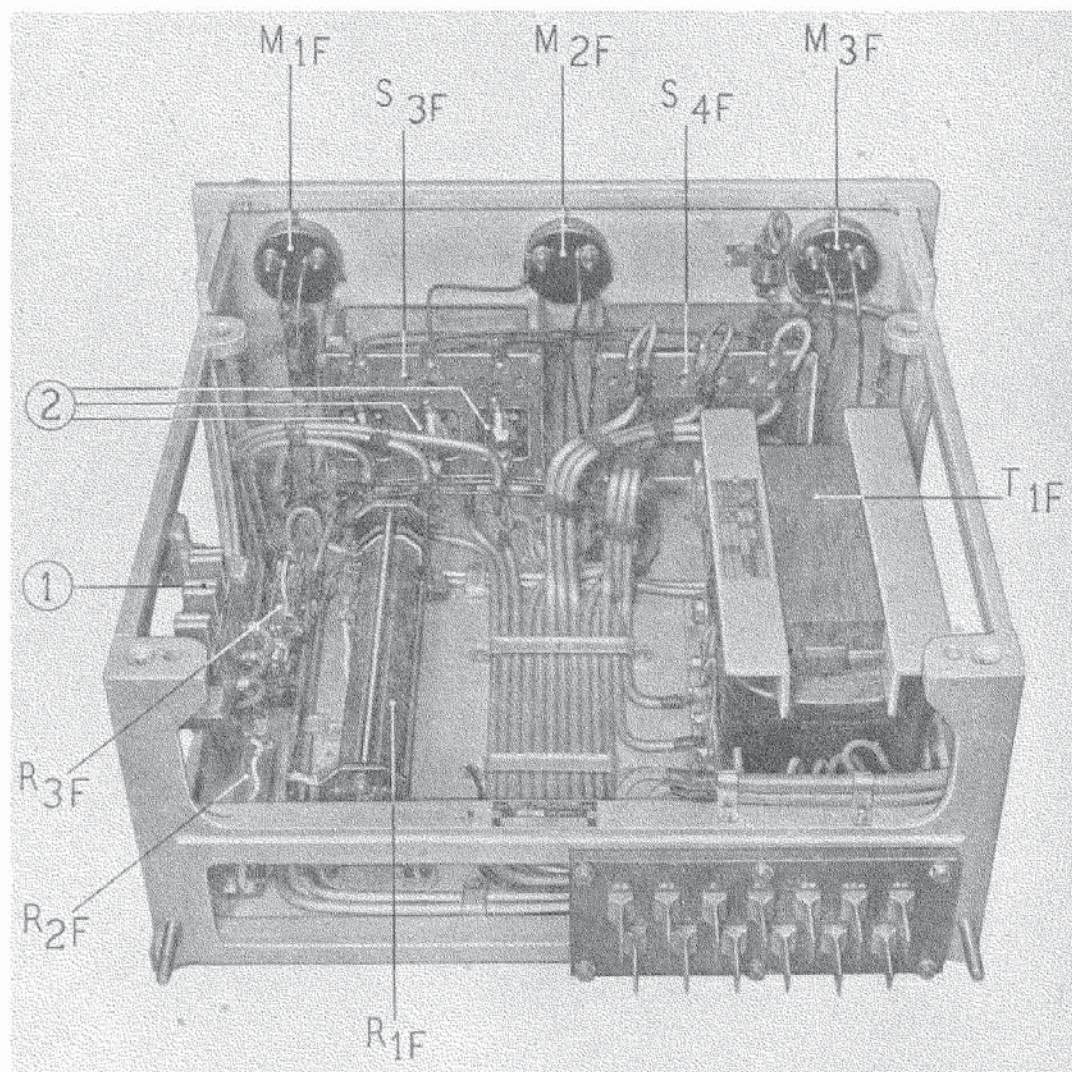
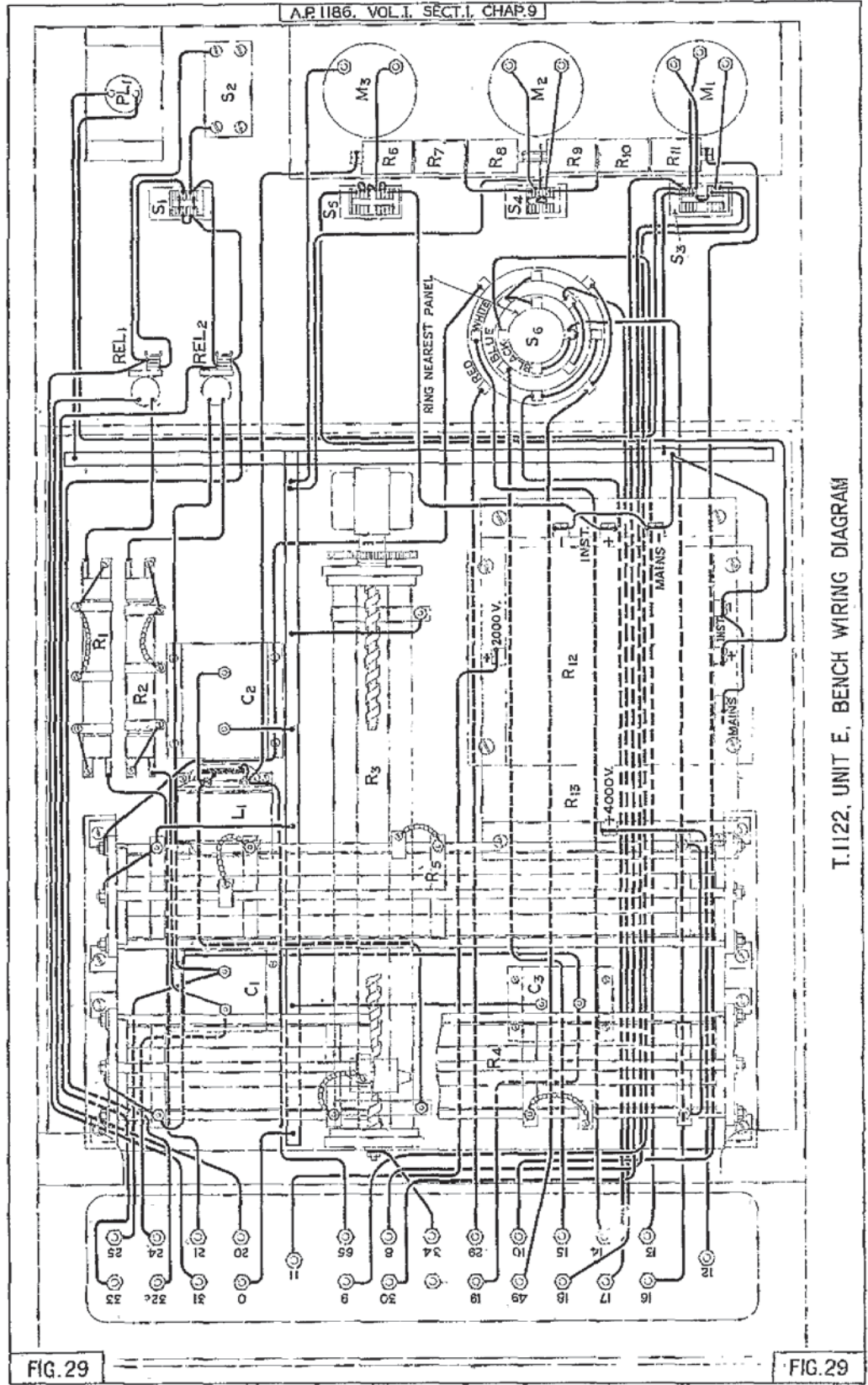


FIG. 28. T. 1122, unit F, topside view.

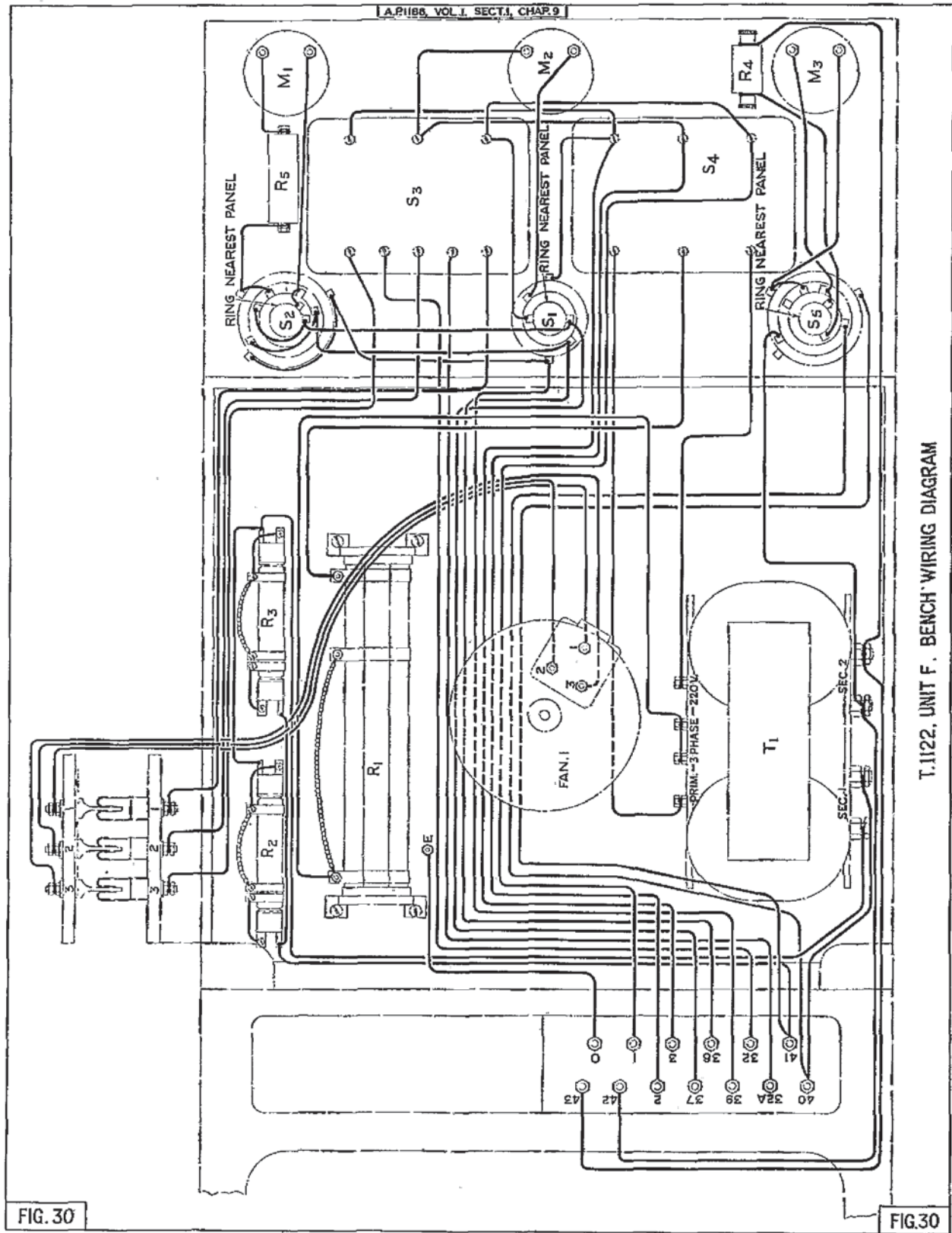
the positions of the radiating dipoles (1) and of the reflectors (2). These are surmounted by the obstruction light (3). The outlets of the cooling system from the transmitter hut are seen at (4) and (5). At (6) are seen the reflector relay boxes, which are shown open in fig. 43, which is annotated in accordance with the theoretical circuit diagram. At (1) is seen the watertight sealing gland of the front, which has been removed for illustration purposes. The reflectors are connected to the relay *via* the insulators (2).

Marker beacons

90. As shown in the illustration, fig. 44, the marker beacon transmitters are installed in small sheds (1) surmounted by the horizontal dipole aerial (2). A metal screen (3) is provided



T.1122. UNIT E, BENCH WIRING DIAGRAM



T.1122, UNIT F, BENCH WIRING DIAGRAM

approximately a quarter wavelength below the aerial to make the radiation shape independent of the humidity of the ground. The marker beacons are normally surrounded by a wooden fence, as are the main beacons.

91. A front view of a marker beacon transmitter, type T.1123, is given in fig. 45. The metal housing (1) is provided with removable back and front covers, which are not shown in the illustration. These are secured in position by the clips (2). The transmitter is fixed to a wooden baseboard (3) by means of brackets provided with shock absorbers, the handle (4) is fitted to facilitate the removal of the transmitter from the hut in which it is installed.

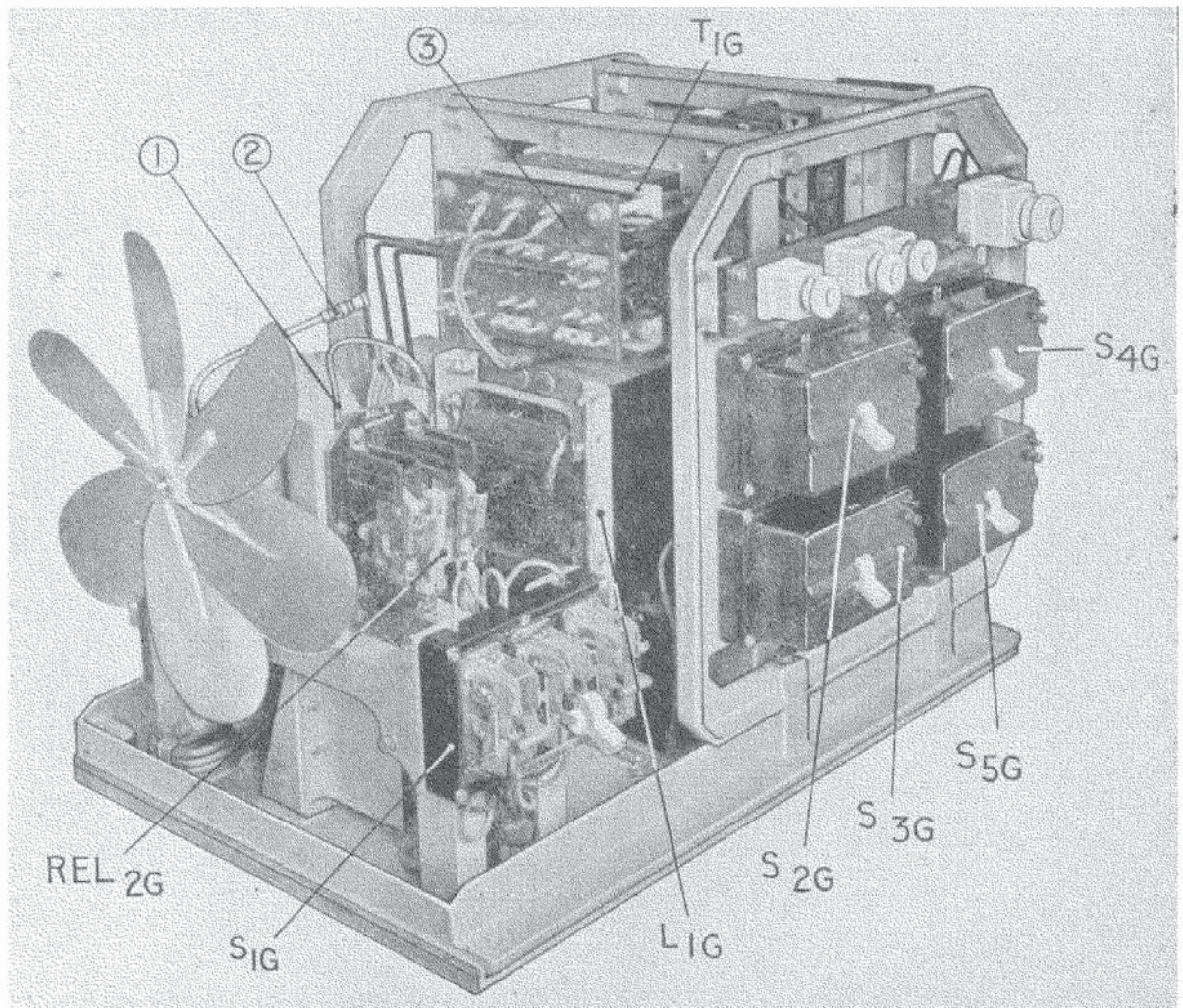


FIG. 31.—T. 1122, unit G, front view.

92. The three screws (5) secure the front and rear assemblies of the transmitter; when these are removed, the front assemblies may be withdrawn by means of the handle (6), or the rear assembly, comprising the power supply unit, may similarly be withdrawn from the rear after removing the rear cover of the transmitter. All the connections to the transmitter are made at the front panel, the sockets (7) accommodating the aerial feeders, and the sockets on the elbow union (8), the leads to the A.C. supply and to the remote control unit. Electrical connections between the supply unit and the modulator unit are effected by means of plugs and sockets. The oscillator amplifier unit is similarly connected to the modulator unit below it. After withdrawing the front assembly, and removing the screws holding the sub-assemblies together, these may be separated along the line (9). The R.F. modulator unit (10) is also connected to the

oscillator amplifier units by plugs and sockets, and may be withdrawn after removing the four captive screws located in the front panel. Tuning is effected by a special tool engaging with the square shanks (11), access to the condensers being obtained by removing the covers (10) and (12). The relay compartment (13) is normally concealed by a screw-on lid.

93. Rear views of the oscillator-amplifier and of the R.F. modulator assemblies are given in fig. 46 and fig. 47 and a bench wiring diagram in fig. 48. Referring to fig. 46, the R.F. modulator panel (1), which is held in position by the screws (2), is mounted in front of the compartment

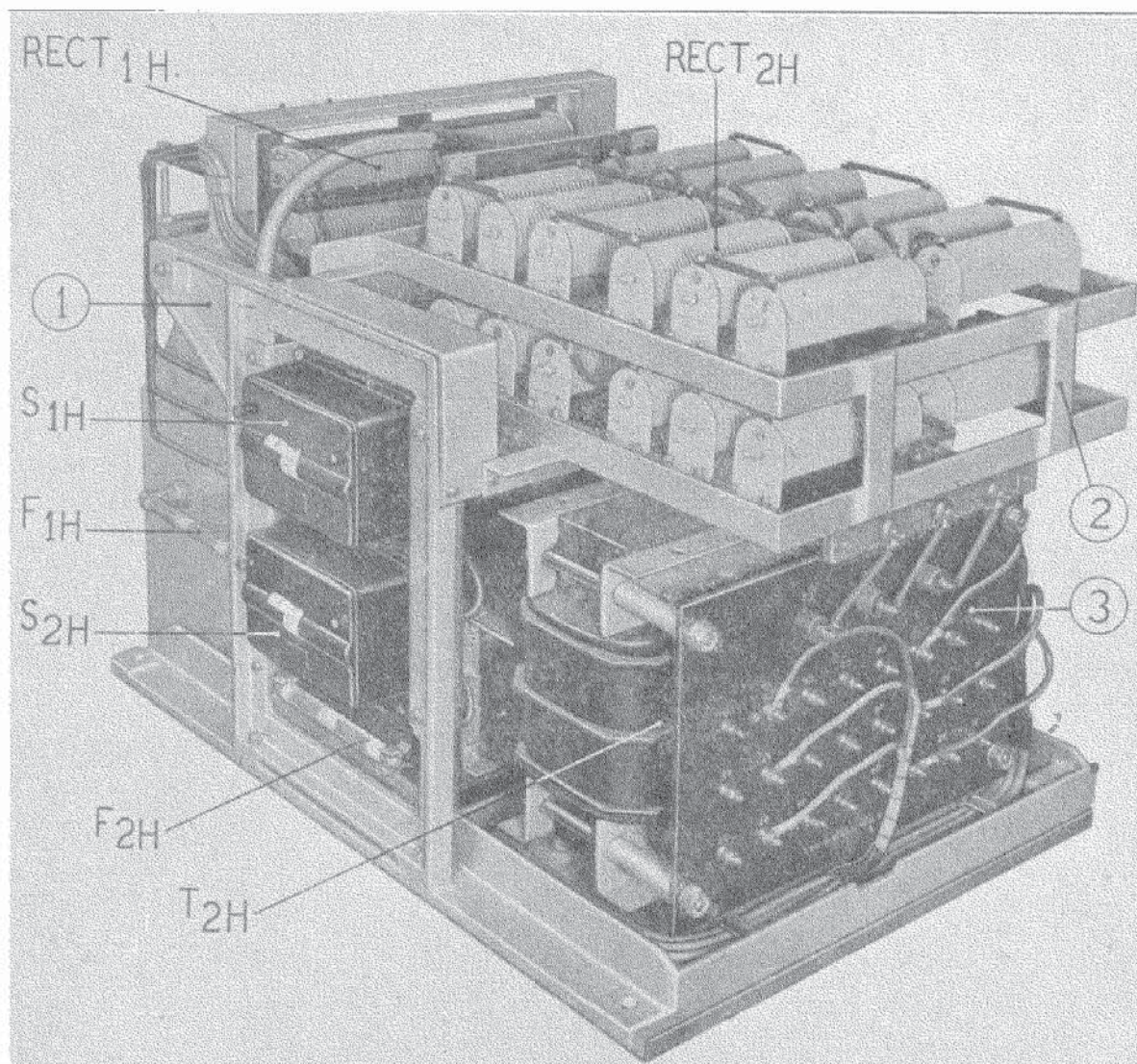
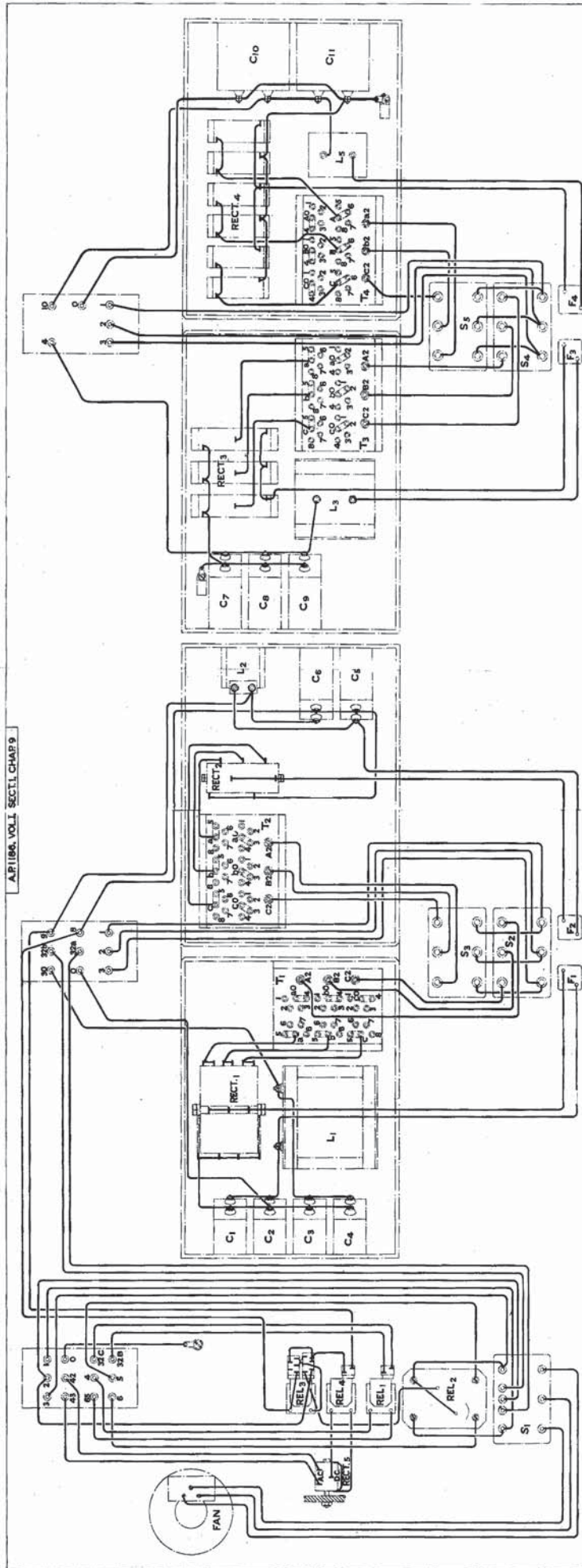
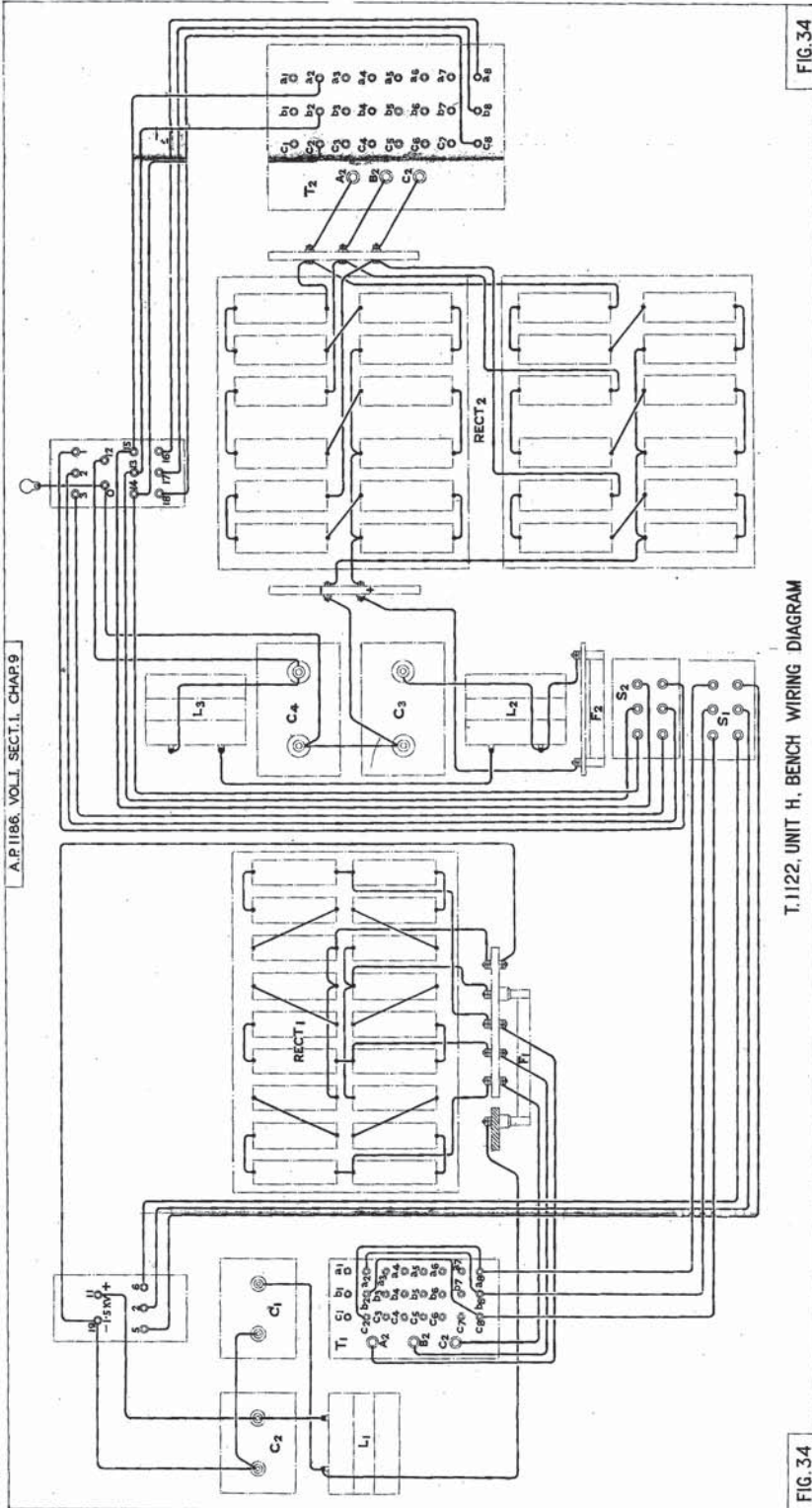


FIG. 32. T. 1122, unit N, front view.

housing of the crystal oscillator, whose R.F. components are principally mounted on the panels (3) which are spaced from the structural members of the assembly by the pillars (4). A spare crystal (5) is fitted by the side of the crystal X_{1R} . The tuning and neutralising condensers C_{7R} and C_{9R} are adjusted by means of a special insulated screwdriver, and their rotor spindles are slotted for this purpose. The centre section of the transmitter contains the components of the mixer valve V_{3R} , which is not seen in the illustration. The aperture (6) in the panel admits the insulated screwdriver used to adjust the neutralising condenser C_{11R} . The screw (7) attaches the assembly to the supply unit, the bosses (8) being provided to secure the oscillator-amplifier and the modulator assemblies together. Electrical connection between these units is effected by the sockets (9) which engage with corresponding plugs in the lower unit. The remaining annotations correspond with those of the theoretical circuit diagram.



T. 1122, UNIT G, BENCH WIRING DIAGRAM



T.1122, UNIT H, BENCH WIRING DIAGRAM

FIG. 34

0.7799, 4.4 C. 1122

94. Referring to fig. 47, connections are made to plugs on the oscillator amplifier unit by means of the sockets (1) mounted on the panel (2). All the components with the exception of the condenser C_{2R} , mounted in the bracket (3), are secured to the base of the cast framework. The

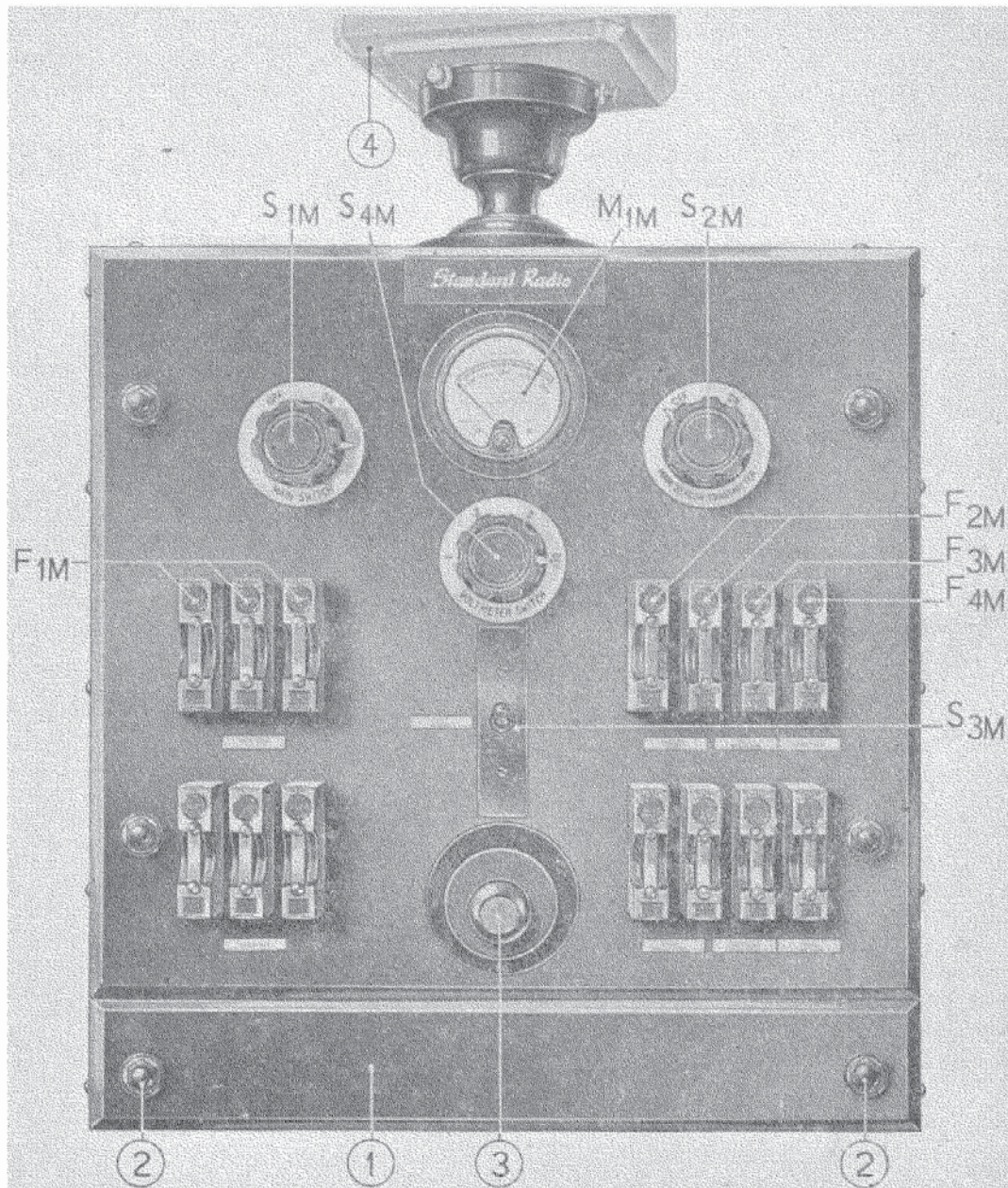


FIG. 35. --T. 1122, unit M, front view.

gear wheel (4), driving the variable condenser C_{1R} consists of two parts, connected together by a spring in order to reduce backlash.

95. Views of the topside and of the rear of the modulator unit, and of the rear of the supply unit are given in figs. 49, 50 and 51, and bench wiring diagrams in figs. 52 and 53. In fig. 51, spur wheel gearing enclosed in the casing (1) drives the keying wheels (2) which operate the keying contacts (3).

Remote control

96. The remote control equipment consists of the supply unit S, which is mounted in a wooden box also containing the alarm buzzer, and of the control unit P, which is contained in a cast alloy housing mounted on a swivelling bracket, thus giving access to the door protecting the wiring at the rear of the equipment.

97. A front view of the supply unit is given in fig. 54 and is annotated in accordance with the theoretical circuit diagram. The louvred metal cover, which has been removed for illustration purposes, is attached by domed nuts screwed on the pillars (1).

98. Front and rear views of the control panel are given in figs. 55 and 56. Referring to fig. 56, the removable covers (1) give access to the lamps and to all the relays with the exception of REL_{5P}, REL_{6P} and REL_{7P}. The cover (2) is provided with an aperture which gives permanent access to the alarm lamp PL_{7P} and the switch S_{6P}. The socket (3) is for connecting monitoring telephones. Bench wiring diagrams of units S and P are given in figs. 57 and 58 respectively.

VALVES AND POWER SUPPLY

99. The crystal oscillator, the R.F. modulator, the mixer, the push-pull amplifier stage 3, and the indicator unit of the main beacon transmitter employ 4033-A valves, six in all. The regulator valve, if fitted, is of the same type. These valves are of the 6.3-volt, indirectly heated type. Stage 4 employs two valves, type 4304-BB, which are fitted with 7.5-volt directly heated filaments. The filament voltage of the two directly heated valves, type 4251-AX, used in the output amplifier, stage 5, is 10 volts. Each of the marker beacons employs seven valves, type 4033-A. The power supply for the main beacon transmitter is taken from 50 cycle three-phase A.C. mains, with a line voltage of 380. Single phase 220-volt 50-cycle A.C. supply is normally used for the marker beacon transmitters, and for the remote control unit, though provision is made in the apparatus for the use of other voltages, as described in this chapter.

INSTALLATION

100. The blind approach transmitter equipment is normally installed by the manufacturers. Care must be taken, however, that certain precautions taken during the installation are not nullified by subsequent modifications. It is essential that no metal work shall be introduced within a 100 yards radius of the main beacon or within the approach sector. Included in this category are wire fencing, including wooden fencing supported by wire, overhead power or telephone lines, ferro-concrete structures, including roadways, and housing with pipe work, electric wiring, etc. For the same reason no bicycles or other vehicles should be parked within this radius. Up to a radius of 500 yards around the main beacon, the ground should be kept clear of any obstruction which subtends an angle of more than 1 in 15 with the main beacon site. The same restrictions apply to the area enclosed by a circle of 100 yards radius centred at the marker beacons. The reciprocal approach sector, if used, should similarly be kept clear of any metal work, including underground pipes and cables. For these purposes, the term approach sector is taken to mean a 30-degree sector each side of the Q.D.M. line.

101. A diagram showing the inter-unit wiring of the transmitter T.1122 is given in fig. 59, and an installation wiring diagram in fig. 60. The greater part of the installation wiring is below the floor of the transmitter hut. Although a continuous length of co-axial cabling is used between the transmitter and the radiating aerial, the reflector aerial switching boxes are fed *via* junction boxes on one of the inner walls of the hut. Generally the cable between the main transmitter and the remote control will be more than six-way, the extra pairs of leads being used for telephonic communication and, when necessary, for controlling obstruction lights. These extra leads will be terminated at the U-link box which connects the six control leads of the transmitter.

102. A typical arrangement of the wiring in a marker beacon hut is shown in fig. 61. Three separate cables are run to the connector, one for the earth, one for mains supply, and one for the control lines. As in the instance of the main beacon transmitter, spare lines may be included in the cable from the inner marker beacon to the remote control. Because of its distance from the aerodrome, the outer marker is normally connected to the remote control by G.P.O. lines, and no spare lines are provided. Radiator lamps, which keep the marker beacon hut at a

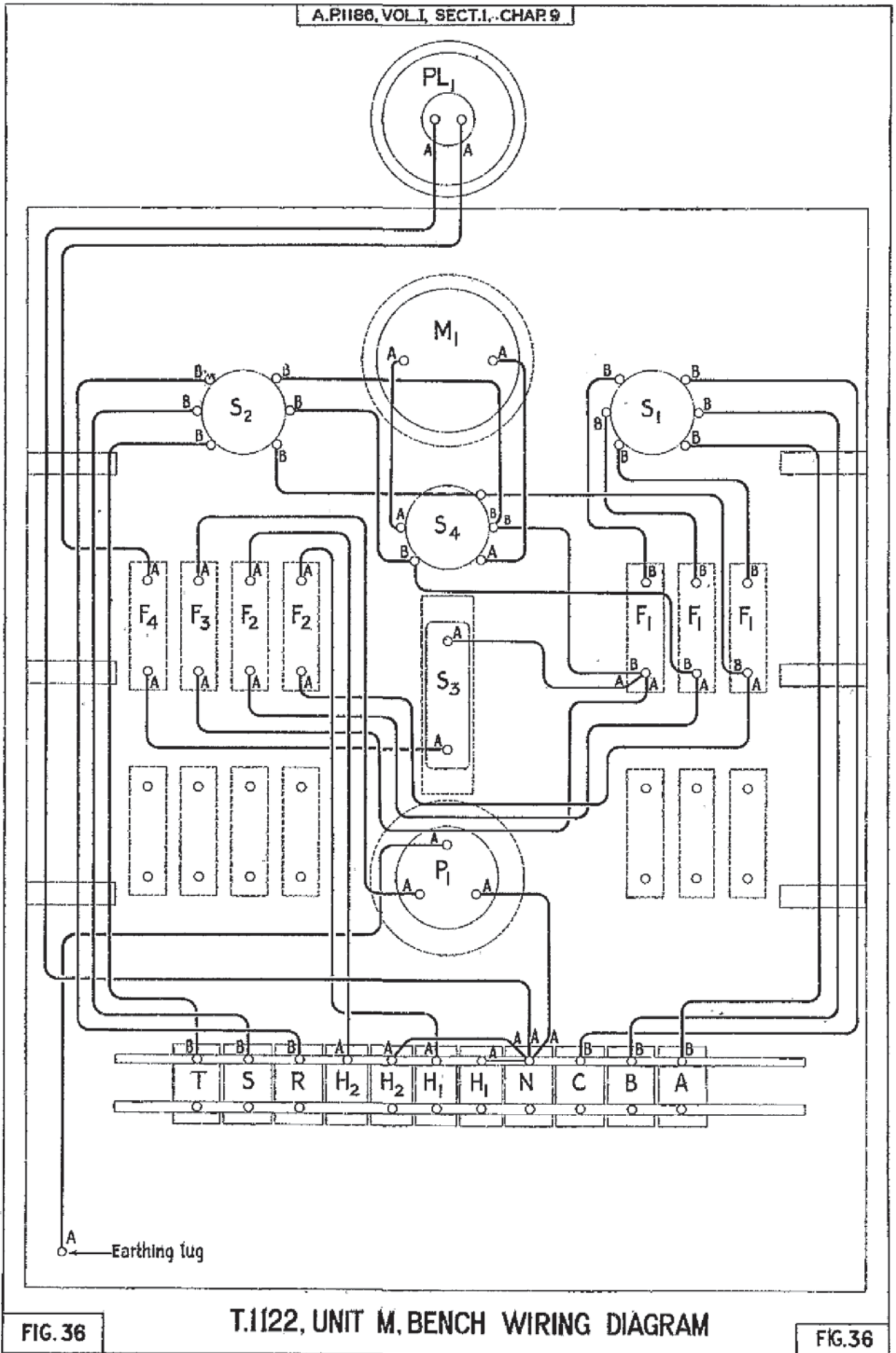


FIG. 36

T.1122, UNIT M, BENCH WIRING DIAGRAM

FIG. 36

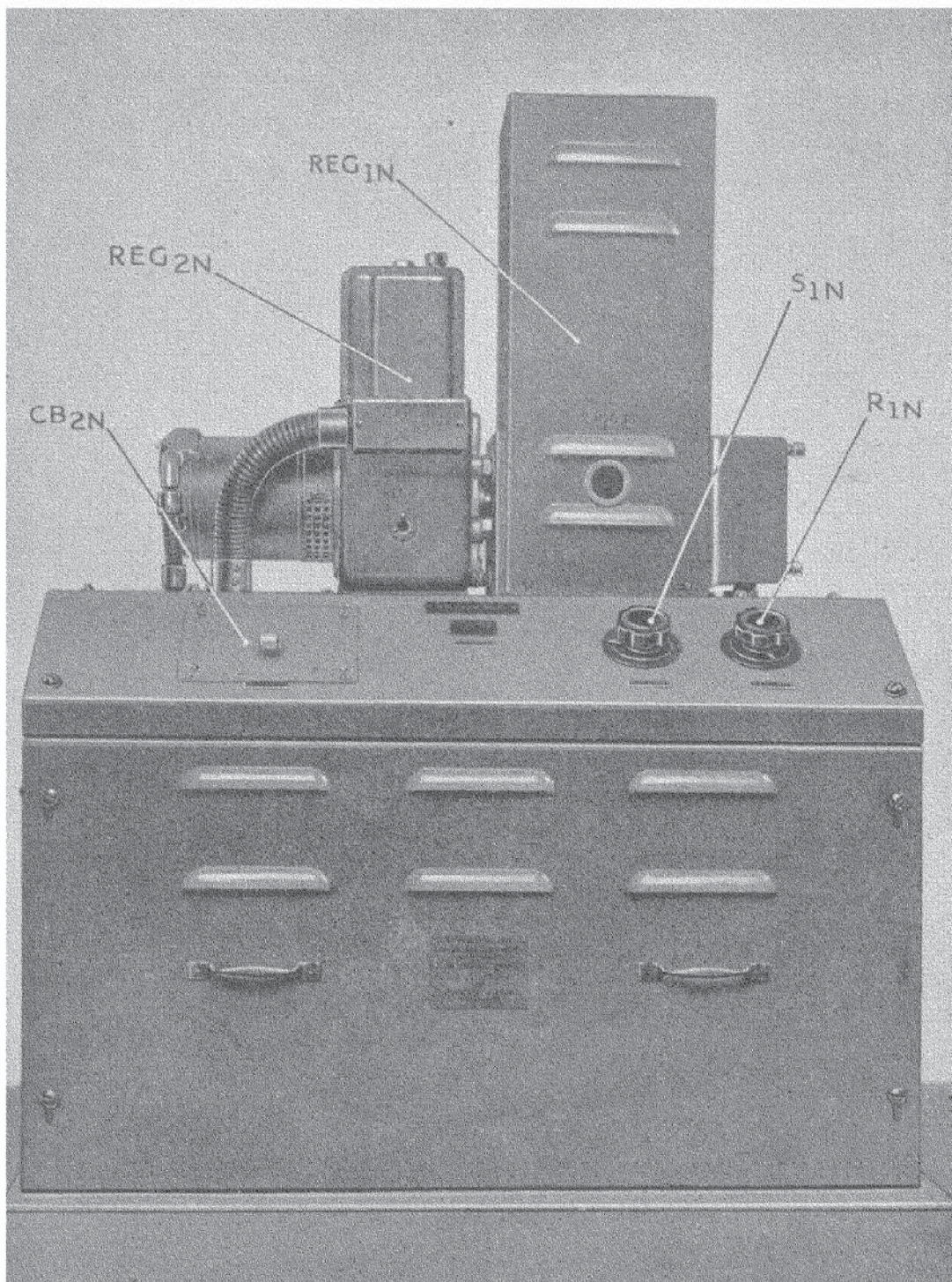


FIG. 37.—T. 1122, unit N, general view.

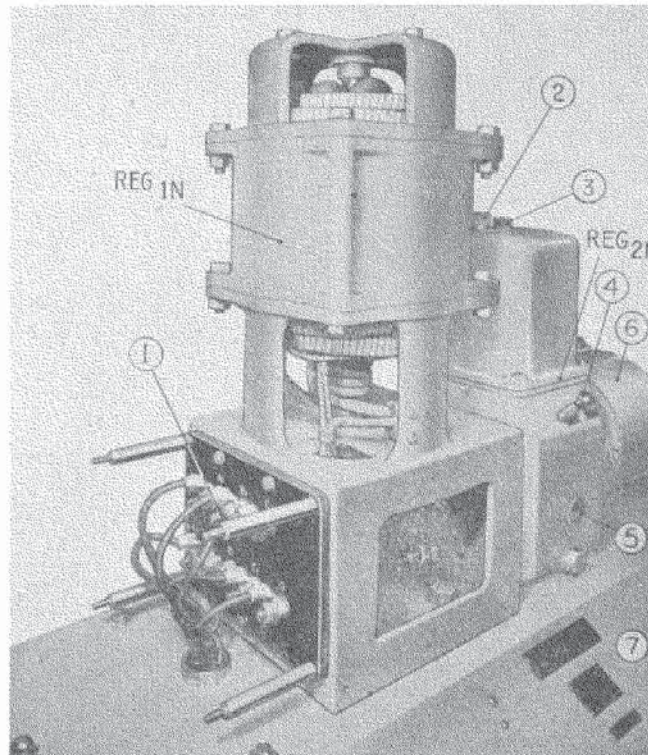


FIG. 38.- T. 1122, unit N, regulator detail.

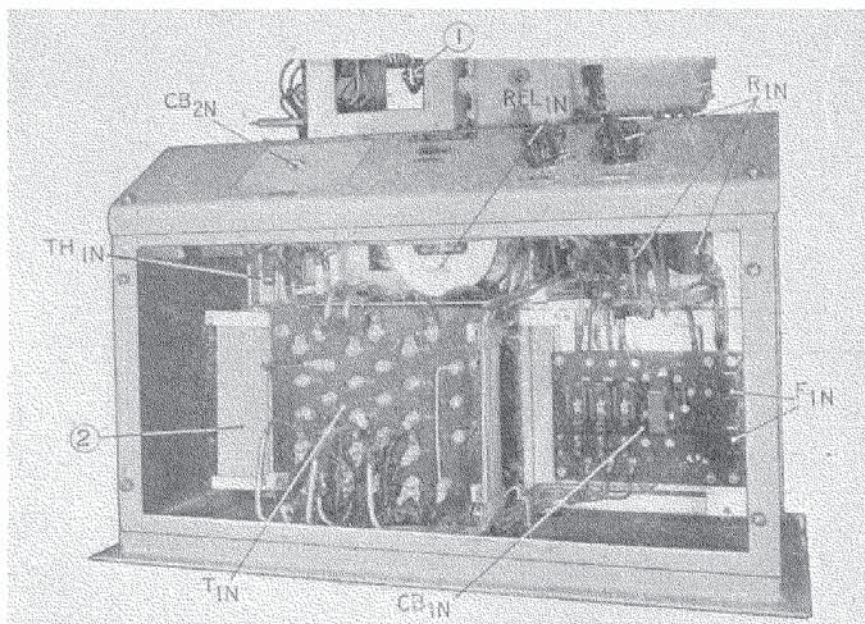


FIG. 39.—T. 1122, unit N, switch gear detail.

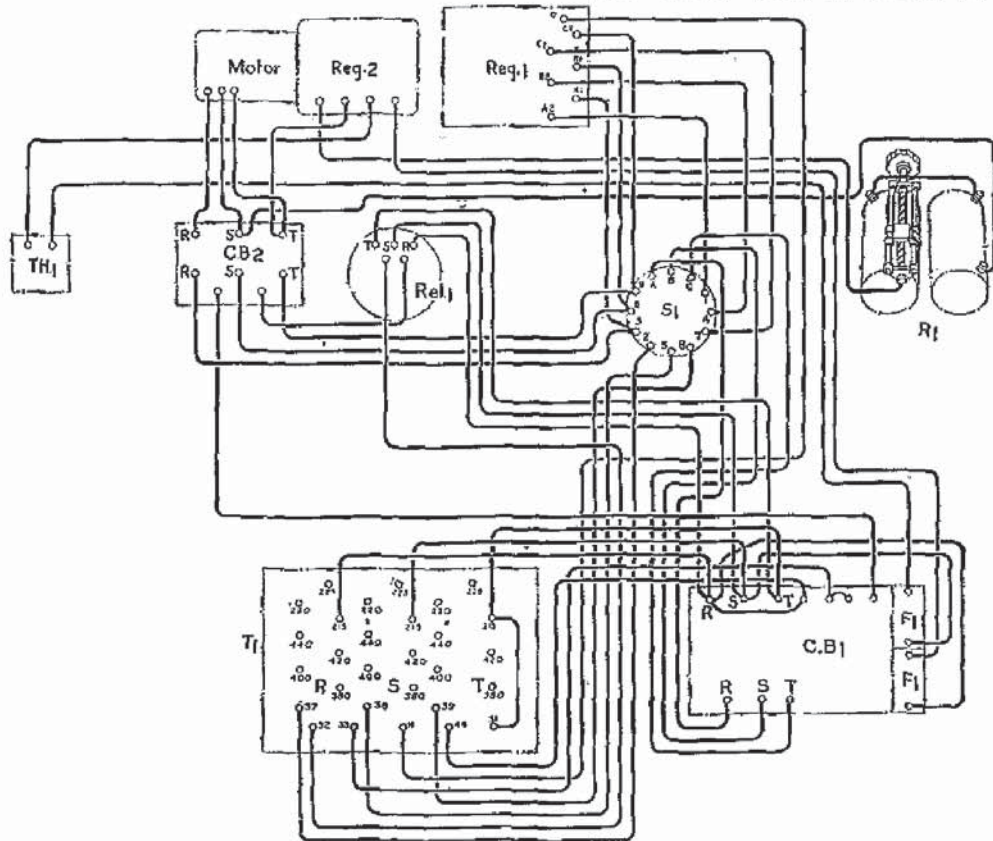


FIG. 40.—T. 1122, unit N, bench wiring diagram.

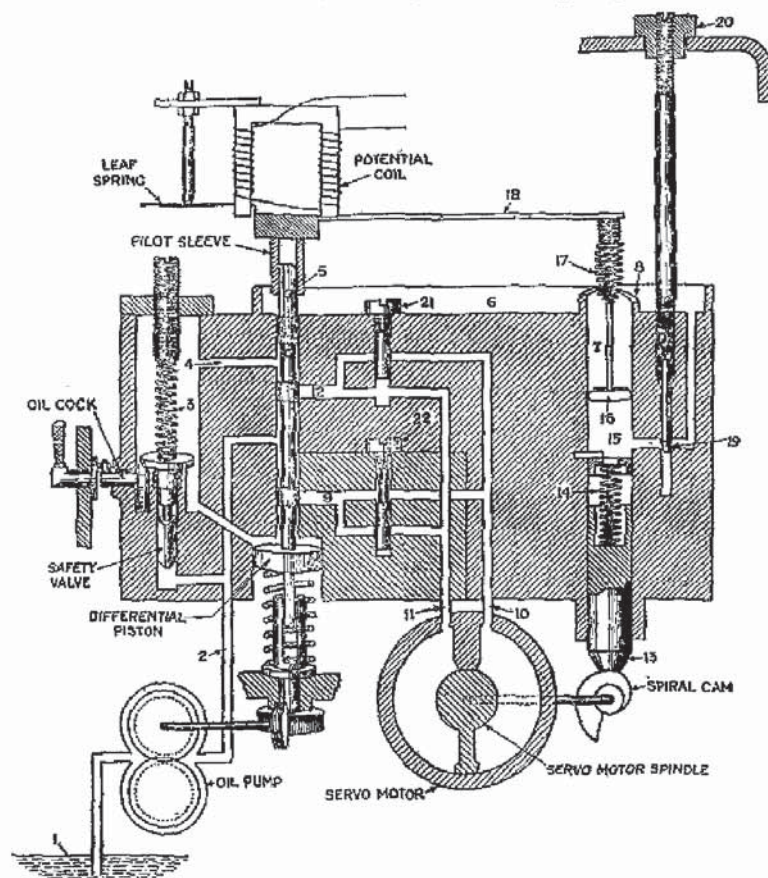


FIG. 41.—Servo motor system.

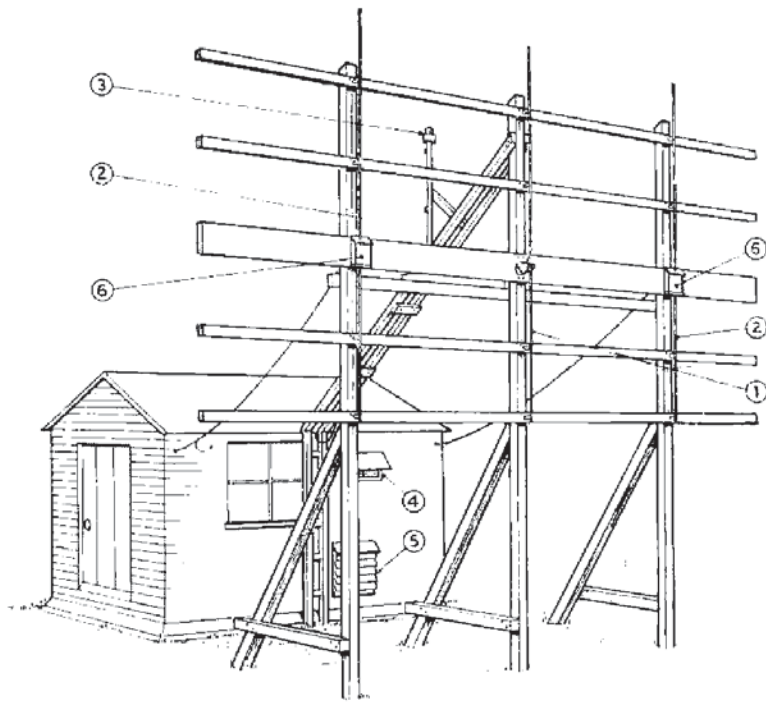


FIG. 42. —T. 1122, aerial system.

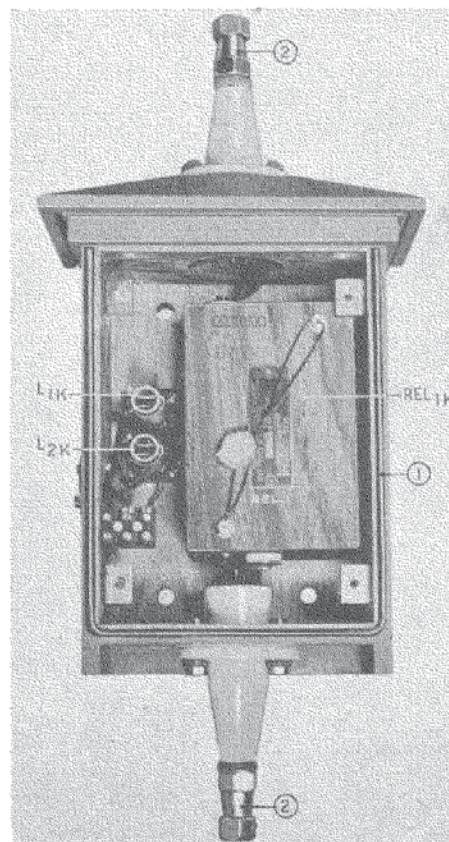


FIG. 43.—T. 1122, unit K, inside view.

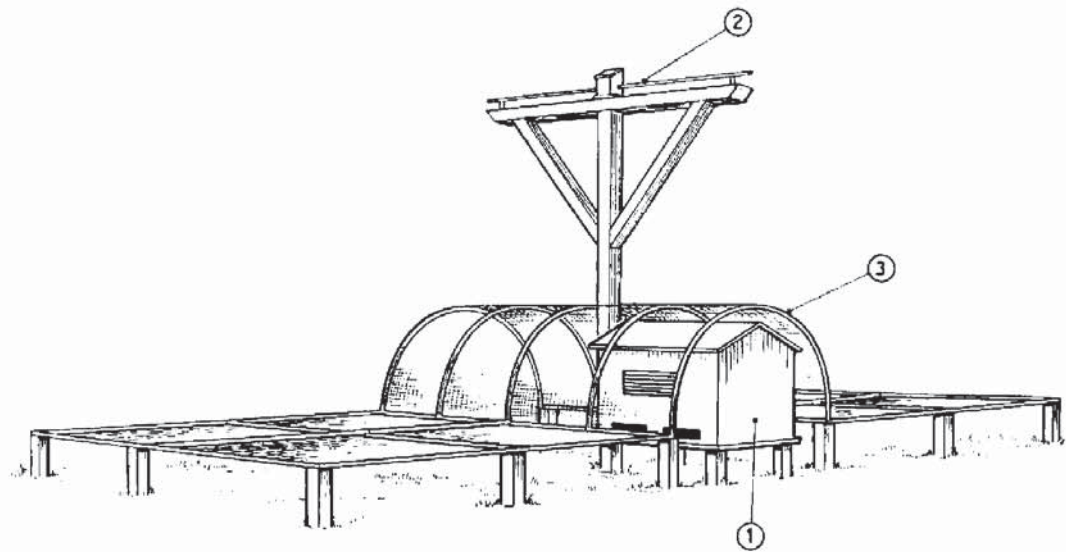


FIG. 44. T. 1123, aerial system.

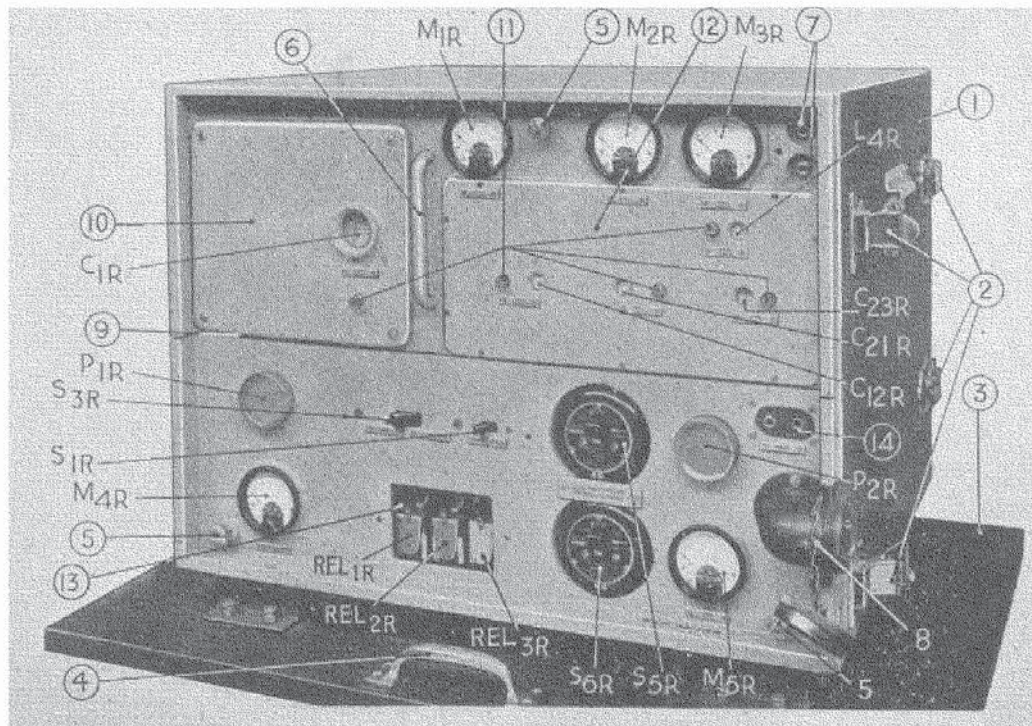


FIG. 45.—T. 1123, front view.

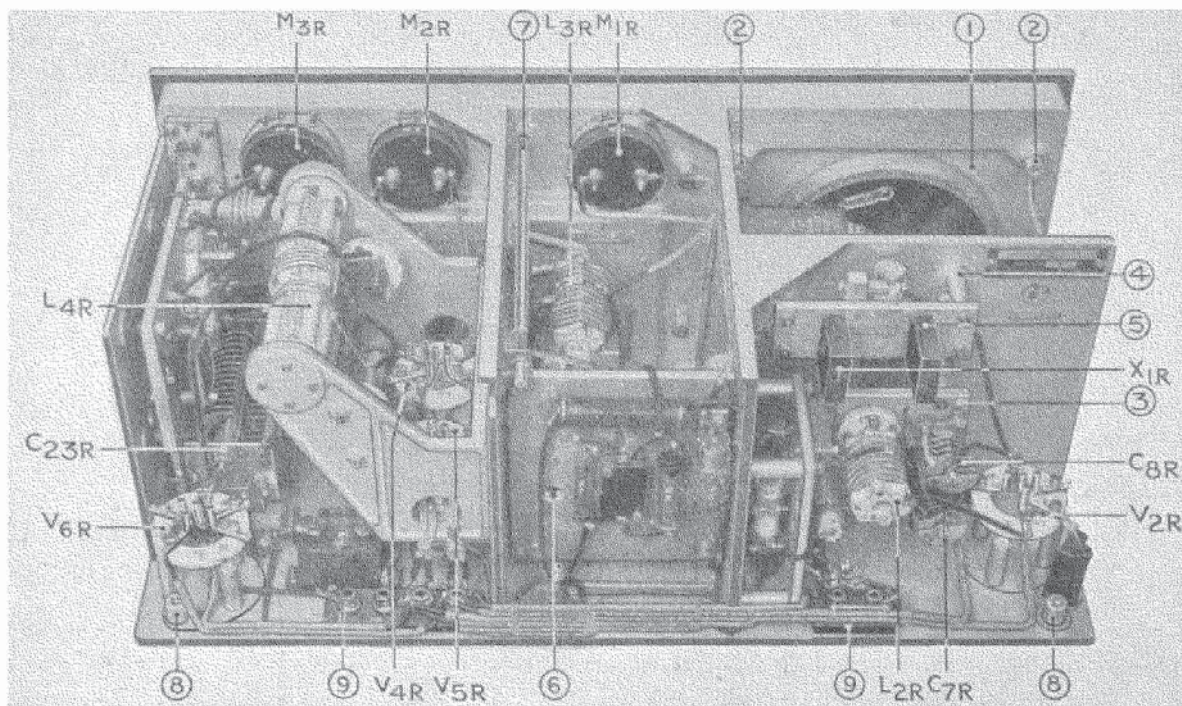


FIG. 46.—T. 1123, oscillator amplifier unit, rear view.

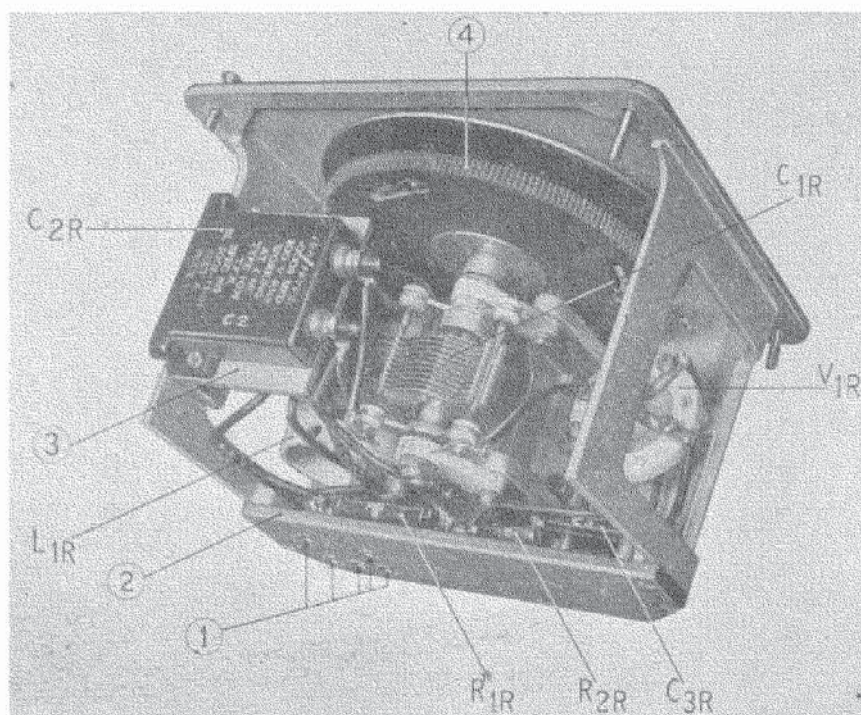
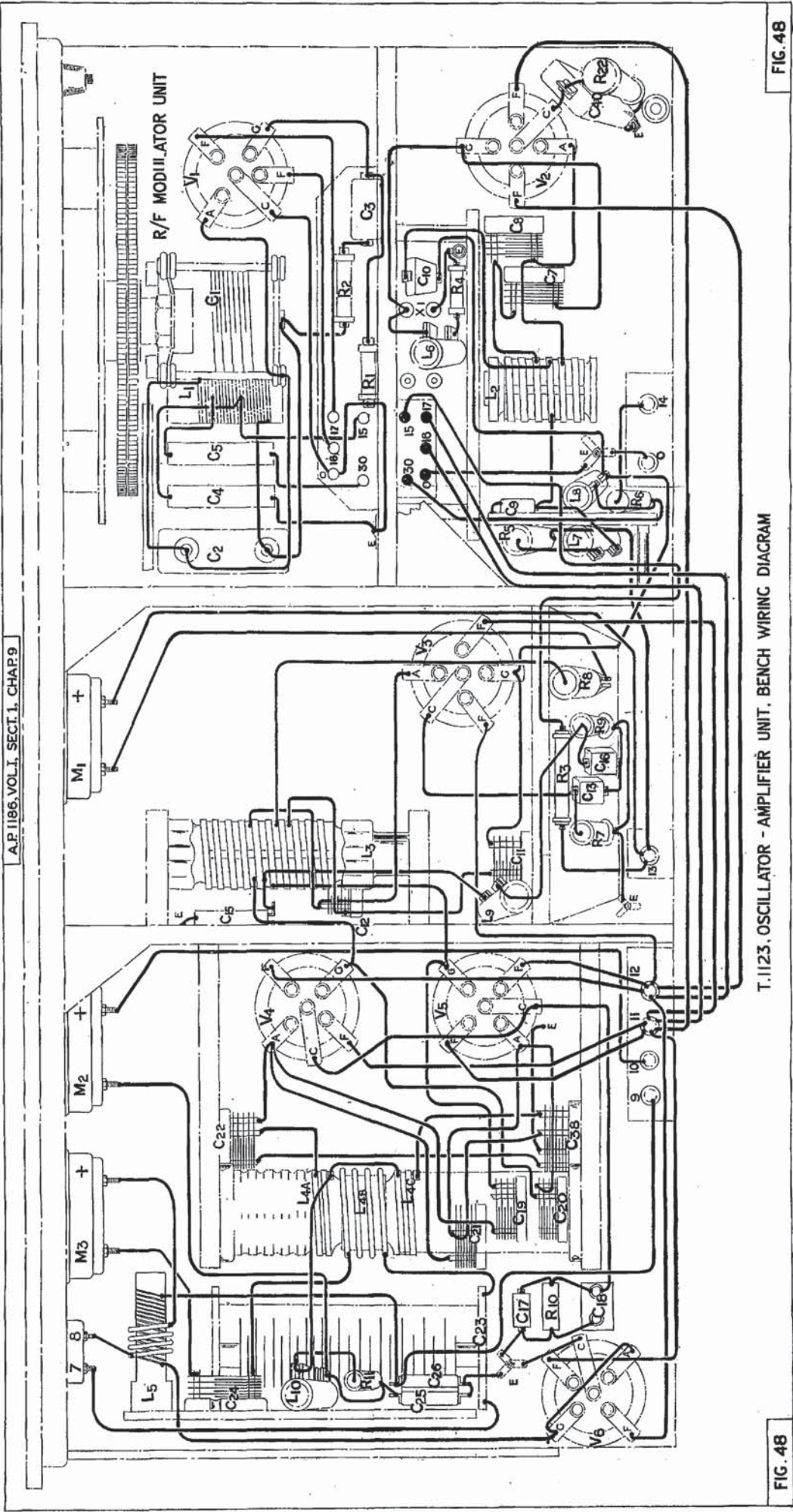


FIG. 47.—T. 1123, R.F. modulator unit, view of topside.



T.1123. OSCILLATOR - AMPLIFIER UNIT, BENCH WIRING DIAGRAM

FIG. 48

FIG. 48

(K.1799), F. & C. LTD

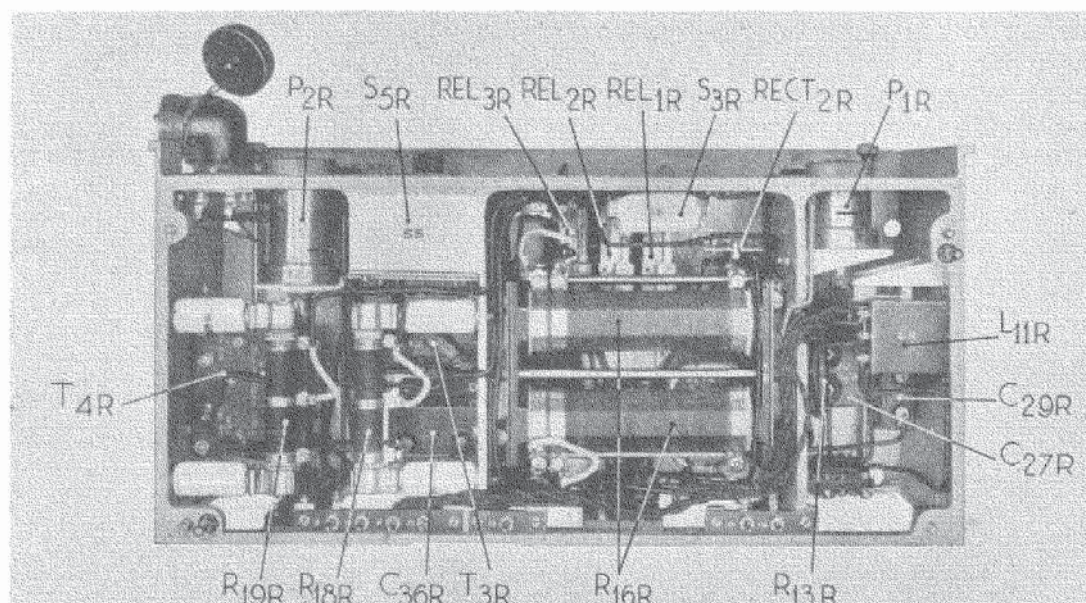


FIG. 49. T. 1123, A.F. modulator unit, view of topside.

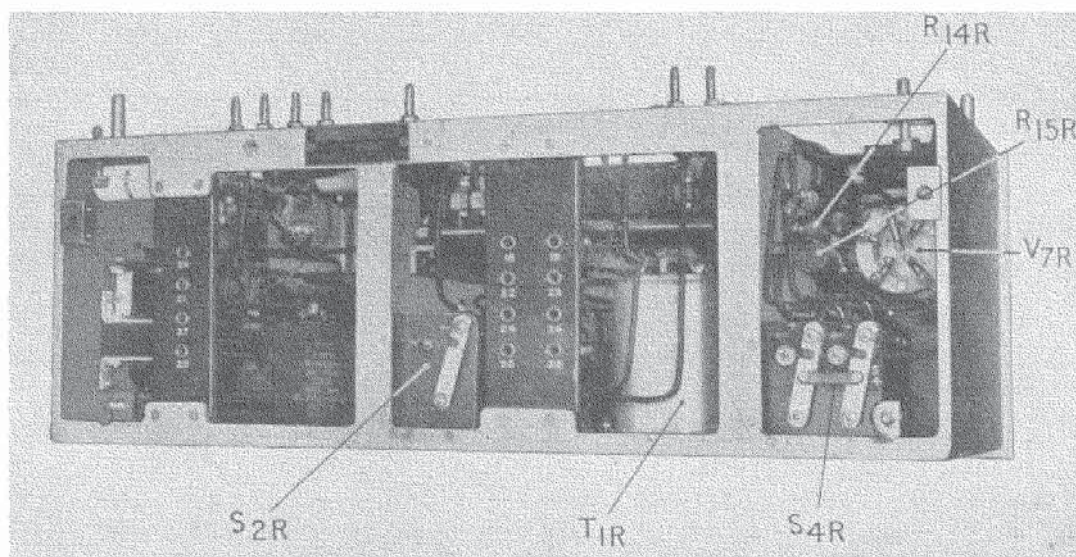


FIG. 50. --T. 1123, A.F. modulator unit, rear view.

desirable temperature, are automatically switched on when the marker beacon transmitter is switched off. The three-pin socket A which supplies power to the marker beacon *via* terminals 5 and 6 has one side connected to the mains through the energising coil of the lamp relay. Therefore, when the transmitter is switched on, the relay is energised, its contacts open and the lamp circuit is broken.

103. The physical arrangement of the items at the remote control may vary with the facilities available, but the electrical arrangement will be as indicated in fig. 62. Generally the terminal strips, U-link boxes, fault warning buzzer and supply unit will be in a light wooden

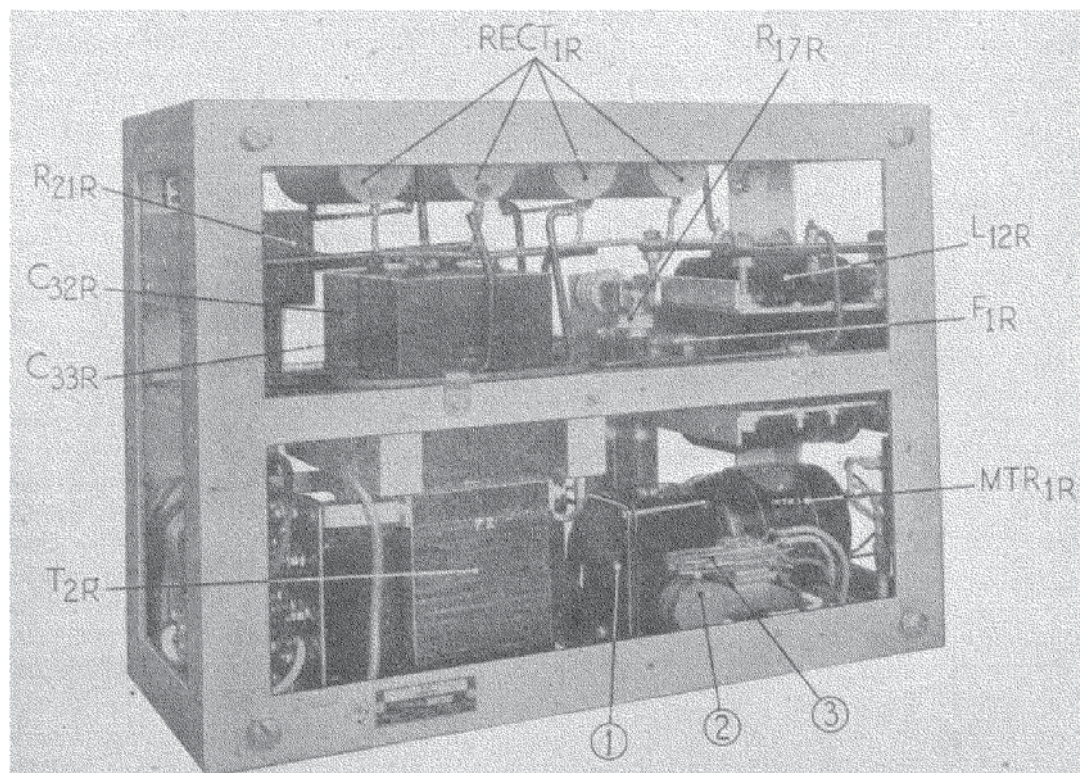


FIG. 51.—T. 1123, supply unit, rear view.

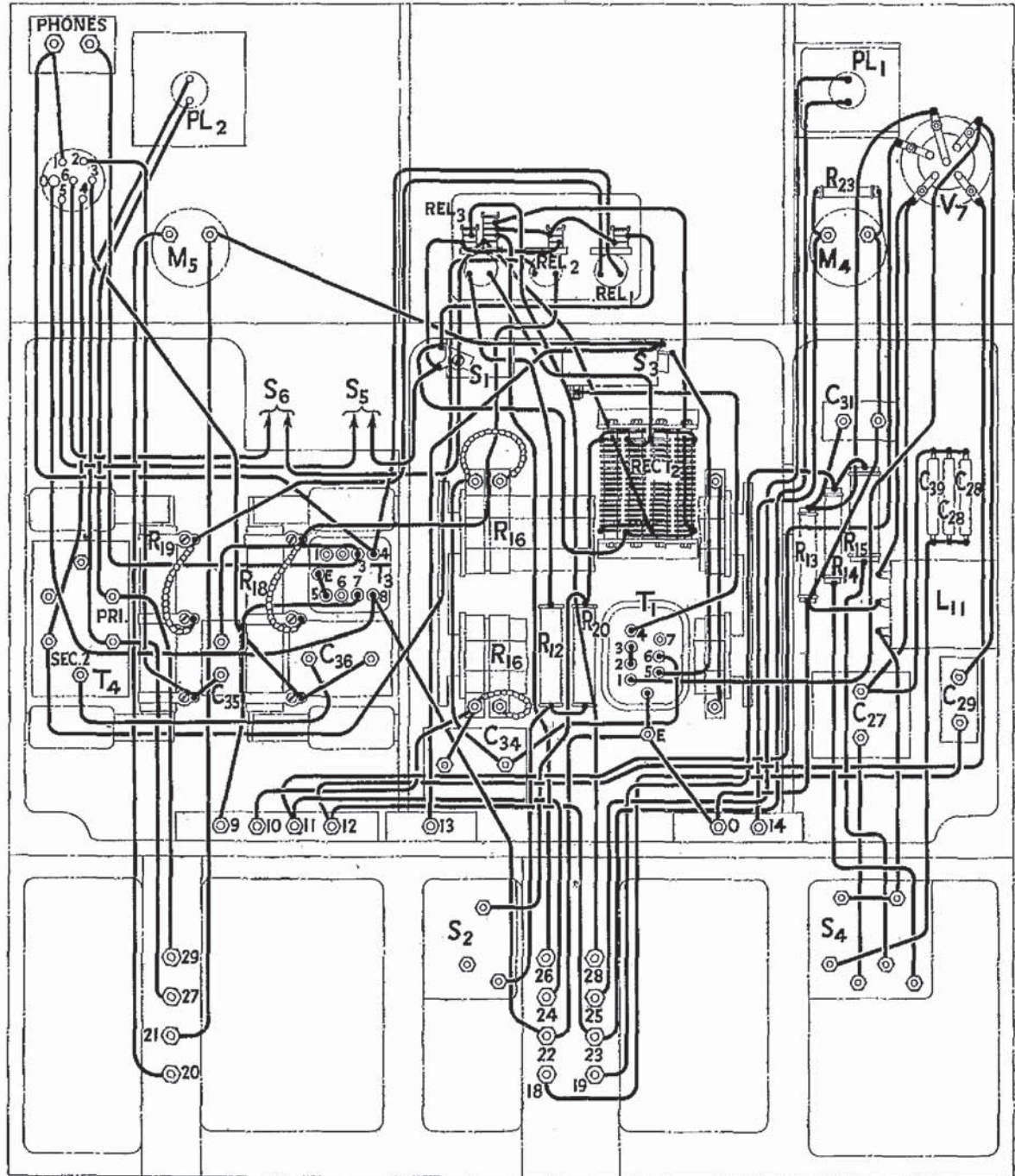
cupboard fitted with a door. In addition to the items shown in fig. 62, there may be press buttons at the remote control point to operate obstruction lights on the main beacon aerial and on the inner marker aerial. The outer marker is sufficiently far from the aerodrome boundary not to require obstruction lights. Remote control for the obstruction lights is provided only when they cannot be supplied from an aerodrome ring-main feeding other obstruction or boundary lights.

OPERATION

104. Complete alignment of the transmitters is not necessary for the normal operation of the equipment, as they are aligned when installed unless the operating frequency is subsequently altered. It may, however, be desirable to check the alignment from time to time. The removal of the crystal or of a valve in any stage will also demand realignment of certain sections of the transmitters. The ensuing paragraphs which describe the complete alignment of the main transmitter and marker beacon transmitters, may be adapted for the realignment of a single section individually. Neutralising is only necessary after a change of valves or frequency.

Alignment of main beacon transmitter.

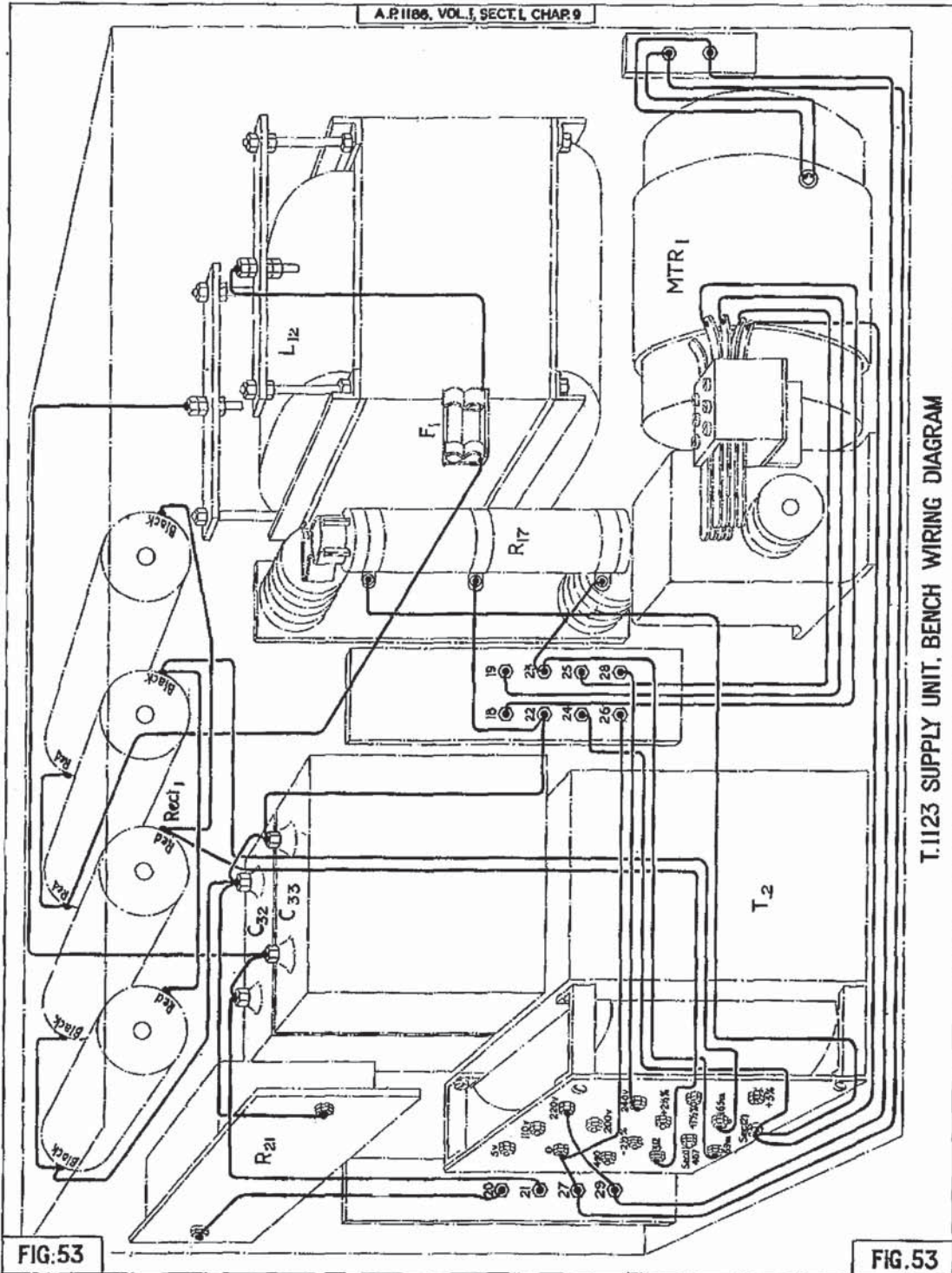
105. For purposes of alignment it is assumed that the main transmitter is operated locally and, except where special instructions are given, in accordance with the information given in the paragraphs on operation. The alignment is divided into six parts beginning with the crystal oscillator, followed by the R.F. modulator and by the mixer, and then the amplifiers of stages 3, 4 and 5.



T.1123, A/F MODULATOR UNIT R, BENCH WIRING DIAGRAM

FIG. 52

FIG. 52



106. The R.F. modulator valve, V_{2A} , and the mixer valve, V_{3A} , should first be removed. The oven should then be switched on, and left for an hour and a half to warm up. Alignment of the crystal oscillator necessitates the removal of the false panel of section A while the main transmitter switch is in the "on" position. For this purpose, a second switch handle should be provided with the transmitter. This second handle should be kept in an inaccessible place so that, for normal working, the possibility of circumventing the safety device does not exist. The removal

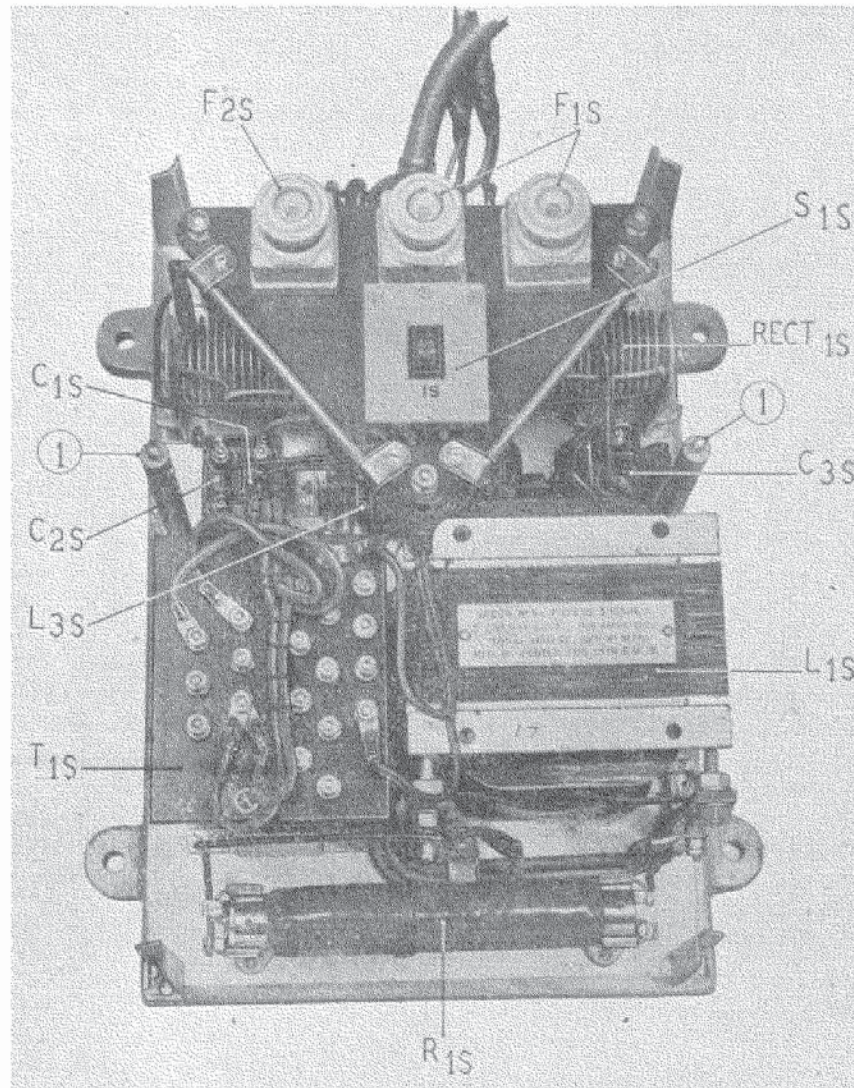


FIG. 54.—Remote control, supply unit S, internal view.

of the false panel gives access to the round plate above the R.F. modulator tuning condenser; the round plate in turn gives access to the spindle of the feedback condenser C_{10A} . The transmitter is now switched on in the normal manner except that the switches of the 1,500-volt and 2,500-volt rectifiers are set in the OFF positions.

107. When the crystal oscillator valve has warmed up, any grid current that flows will be indicated on the milliammeter M_{1A} , engraved GRID CURRENT, STAGE 1, which is the extreme left-hand of the four meters on section A. If zero reading is shown on the meter, the crystal stage tuning condenser should be slowly rotated through 180 degrees while the meter is watched. If a deflection of the needle is still absent the spindle of the feedback condenser C_{10A} should be turned a few degrees in a clockwise direction with an insulated screwdriver. If a sharp upward

kick of the meter needle does not now occur at some point on the 180-degree range of the tuning condenser, a further clockwise turn of a few degrees should be given to the feedback condenser. This procedure should be continued until an upward kick of the meter is obtained over two or three degrees of the tuning condenser. It is essential that the minimum feedback consistent with oscillation be employed, as otherwise spurious oscillation may result. The needle of the meter should deflect over two or three degrees of the tuning condenser only, rising sharply during deflection to a maximum and falling again to zero. If there is a small deflection of the meter at all settings of the tuning control, the feedback condenser has been turned too far in a clockwise direction and should be turned back a little. The final setting for the tuning is one-half of a degree lower than the setting which gives maximum deflection of the meter M_{1A} .

108. On the setting of the R.F. modulator depends the frequency at which the transmitter will radiate. The frequency allocated to the stations will be known, and the exact frequency of the crystal will also be known. This latter information for the two crystals supplied with the transmitter will be found on a calibration chart affixed to the inside of the false panel of section A. When the transmitter operates on the sideband represented by the sum of the frequencies of the crystal and the R.F. modulator, the frequency setting of the R.F. modulator may be found by subtracting the crystal frequency from the desired operational frequency. If the operational frequency required is 39.50 Mc/s and the crystal to be used oscillates at 37.05 Mc/s, then the R.F. modulator has to be set to a frequency of $39.50 - 37.05 = 2.45$ Mc/s. The calibration chart for the R.F. modulator normally shows the dial settings of its tuning condenser for frequencies between 2.30 Mc/s and 2.50 Mc/s. The settings for the two crystals provided with the transmitter are stated on the chart and do not have to be read from the curve. When the required operational frequency is less than the crystal frequency, the R.F. modulator is the difference of the two, and mixer and subsequent stages are tuned to the operational frequency.

109. The R.F. modulator tuning may be set with the false panel of section A in position if its correct setting is noted beforehand on the calibration chart, but the oven must be given time to warm up fully before the setting is finally effected. The valve V_{1A} may remain in its holder, but it is advisable to remove the valve V_{3A} and to switch on the transmitter, the 1,500-volt and 2,500-volt rectifier circuit breakers being in the OFF position. If the R.F. modulator valve is oscillating, the second meter from the left on section A, which indicates the anode currents of the R.F. modulator, should give a reading between the red marks on its scale. Altering the R.F. modulator tuning from 0 degrees to 180 degrees should not affect the reading of the anode current meter. The tuning condenser of the R.F. modulator is set to the frequency stated to the calibration chart for the particular crystal in use. If a crystal other than one originally supplied with the transmitter is in use, the correct setting for the tuning condenser is read from the curve on the calibration chart. The R.F. modulator requires no attention other than the setting of its tuning. Note that the red marks on the meter scales apply only to the operating conditions when using specified valves and crystals, and are not necessarily reliable if these components are changed.

110. The false panel of section A requires to be removed for the alignment of the mixer valves, V_{3A} , to give access to the control spindle of the neutralising condenser C_{14A} . The push-pull valves V_{4A} and V_{5A} should be removed during alignment of the mixer stage, and the high voltage rectifier switches should be in the OFF position.

111. The voltage applied to the grid cathode circuit of the mixer valve by the combined output of the crystal oscillator and R.F. modulator is a mixture of several frequencies. In addition to the crystal and R.F. modulator frequencies, there are present the sum and difference of these two, and the sum and difference of the crystal frequency and twice the R.F. modulator frequency and also others. It is essential that the anode circuit be tuned to the required frequency, and care must be taken over this operation. The correct setting of the tuning condenser is stated on the calibration chart and will be the same for any crystal. Should the frequency in which the transmitter is to operate be changed, the mixer tuning condenser will have to be reset. The new setting is determined in the following manner. In addition to removing the valves V_{4A} and V_{5A} , the R.F. modulator valve V_{2A} should be removed: the only frequency present across the grid and cathode of the mixer valve will then be that of the crystal. The mixer is tuned to this frequency by adjusting the tuning condenser C_{15A} until the reading of the anode circuit meter M_{3A} becomes a minimum. The corresponding scale reading of this condenser C_{15A} should be noted.

112. The R.F. modulator valve V_{2A} should then be replaced and given time to warm up.

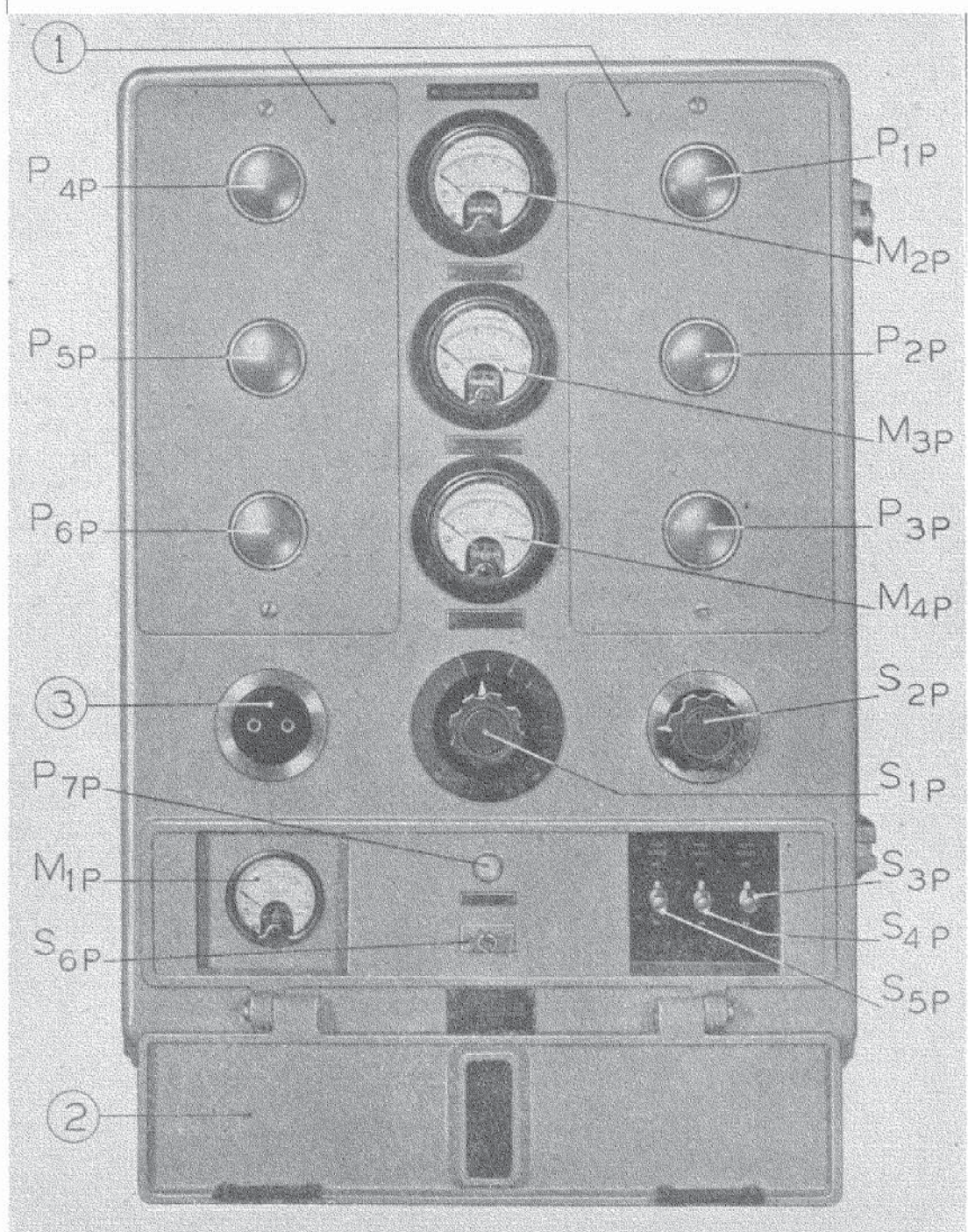


FIG. 55.—Remote control panel, front view.

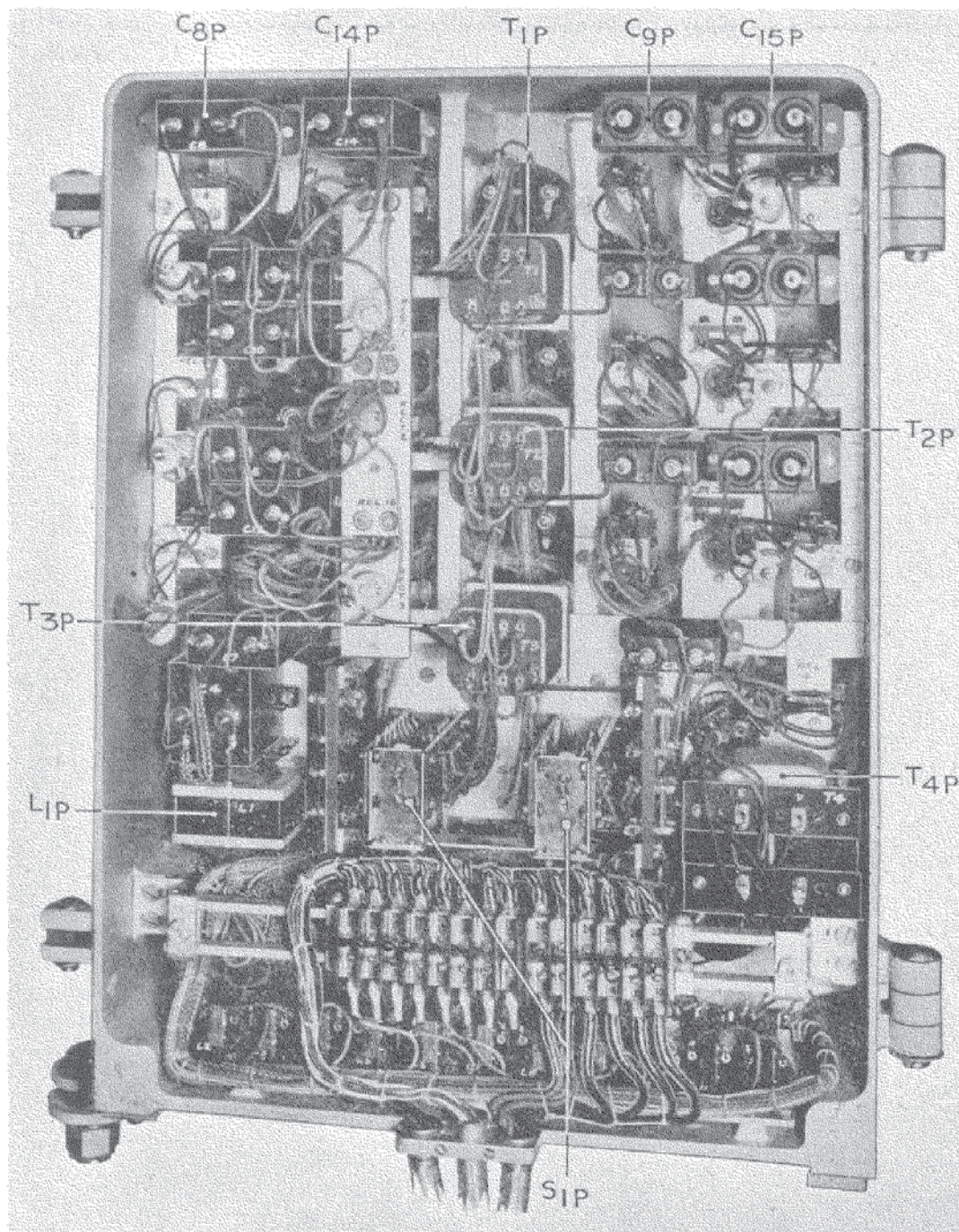
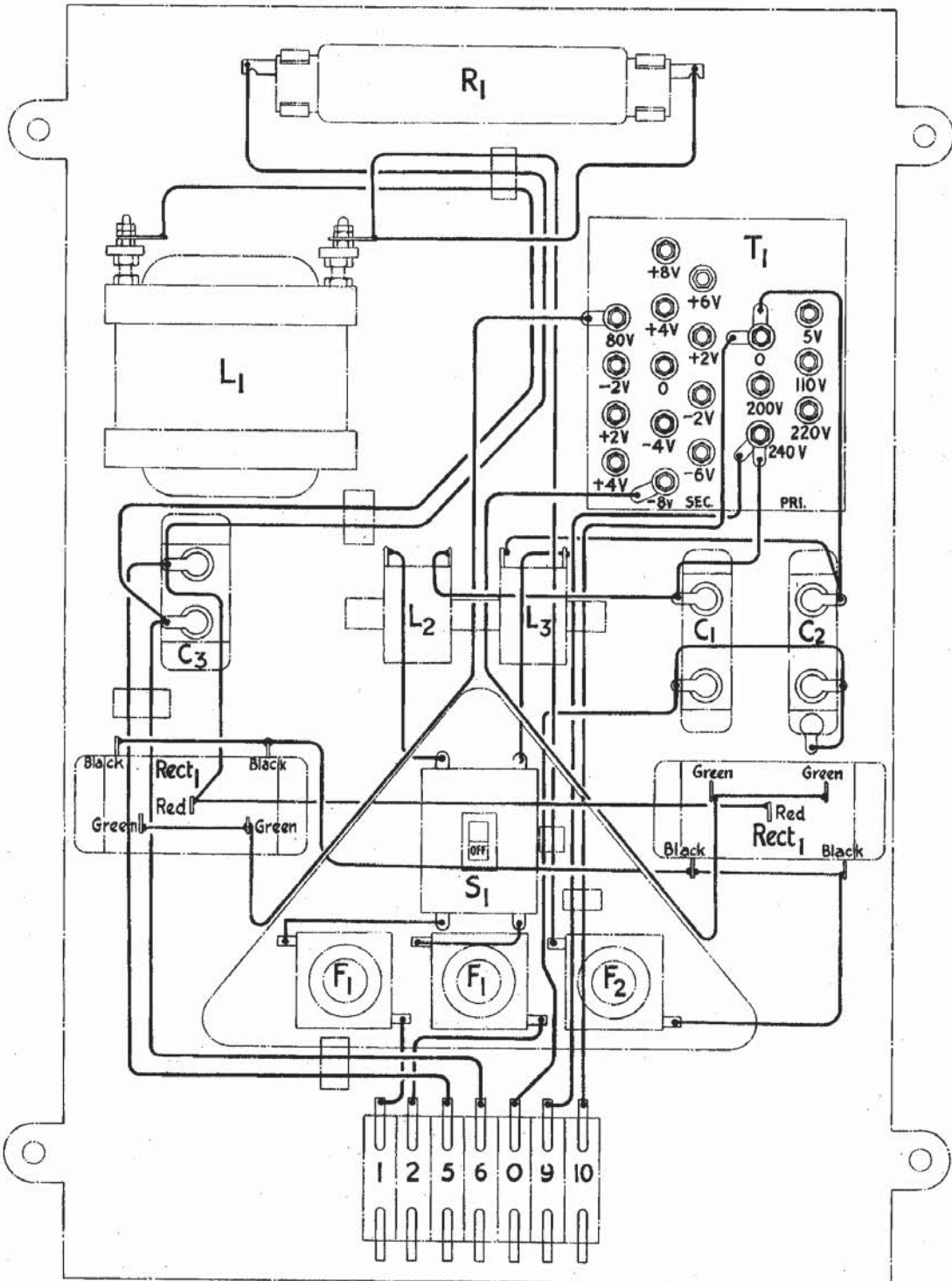


FIG. 56. —Remote control panel, rear view.



REMOTE CONTROL SUPPLY UNIT S.
BENCH WIRING DIAGRAM

FIG. 57

FIG. 57

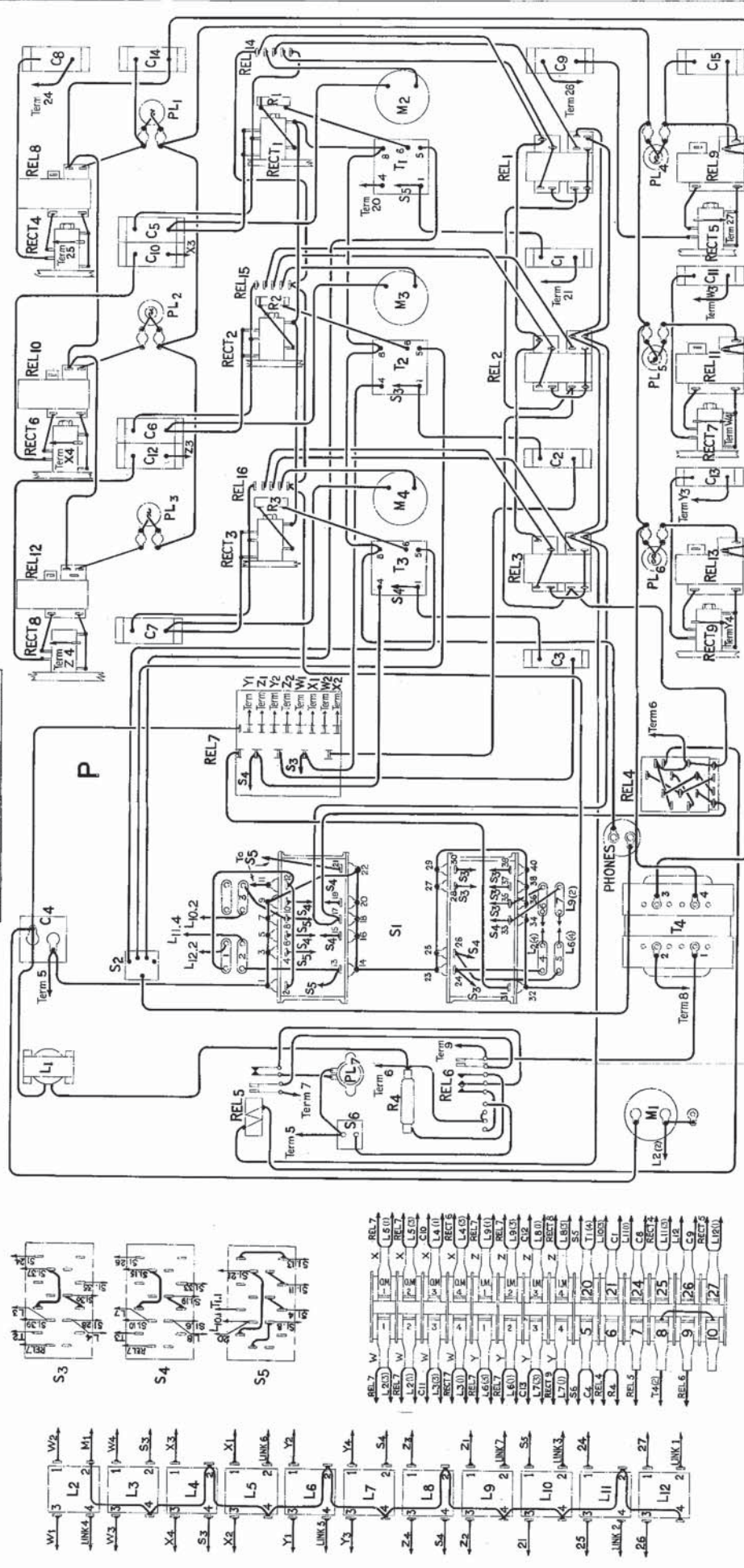


FIG.58

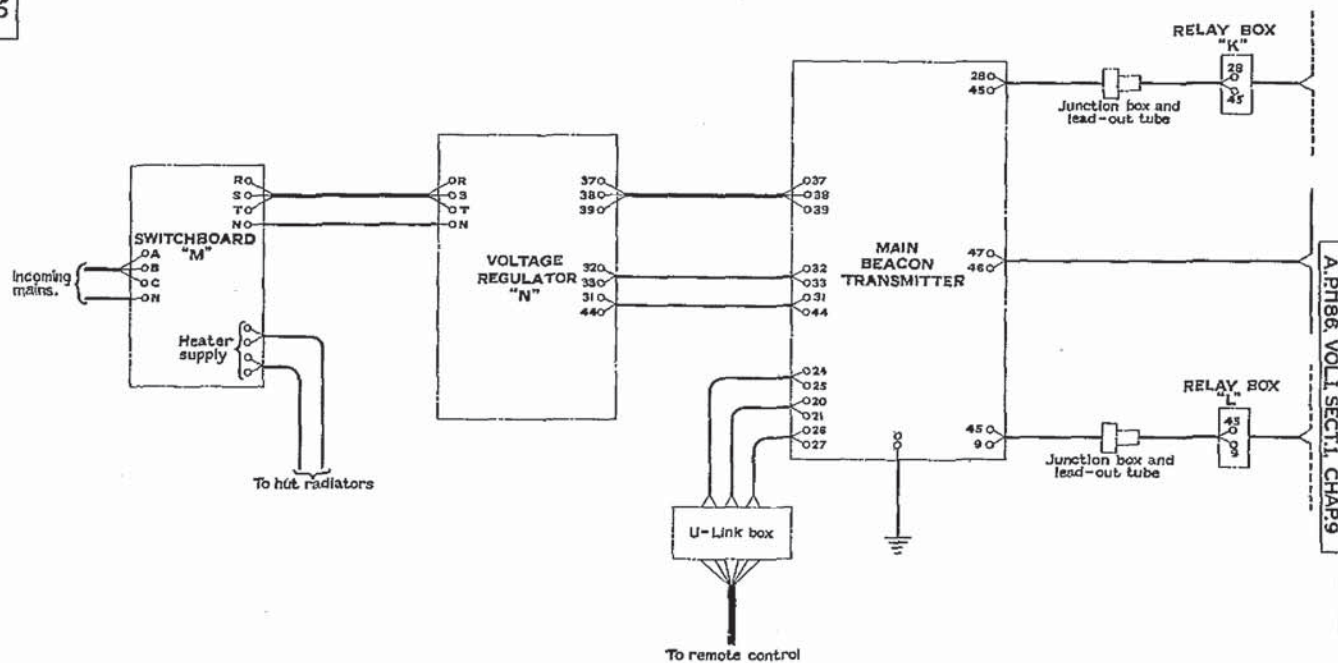
REMOTE CONTROL PANEL P, BENCH WIRING DIAGRAM

FIG.58



T.1122, INTER - UNIT WIRING DIAGRAM

FIG. 60



MAIN BEACON INSTALLATION WIRING

FIG. 60

A deflection of the anode-current meter will still occur at the noted reading, but at least two other points will be found on each side of this setting at which deflections also occur. The correct setting, assuming that the higher sideband of the mixed crystal and R.F. modulator outputs is required, corresponds to the greatest deflection of the meter needle when the condenser scale reading is about 20 divisions above the setting previously noted. If the condenser dial is so calibrated that the scale reading increases as the capacitance increases, the final setting should be approximately 20 divisions *below* the previous setting. The exact setting should be noted. Other deflections, corresponding to resonance at unmarked frequencies, will be observed with condenser settings about 40 divisions above, and 20 and 40 divisions below the setting for the crystal alone. Observation of these may help in locating the exact setting required. On completion of this operation, neutralisation of the stage may be proceeded with, though this is normally unnecessary.

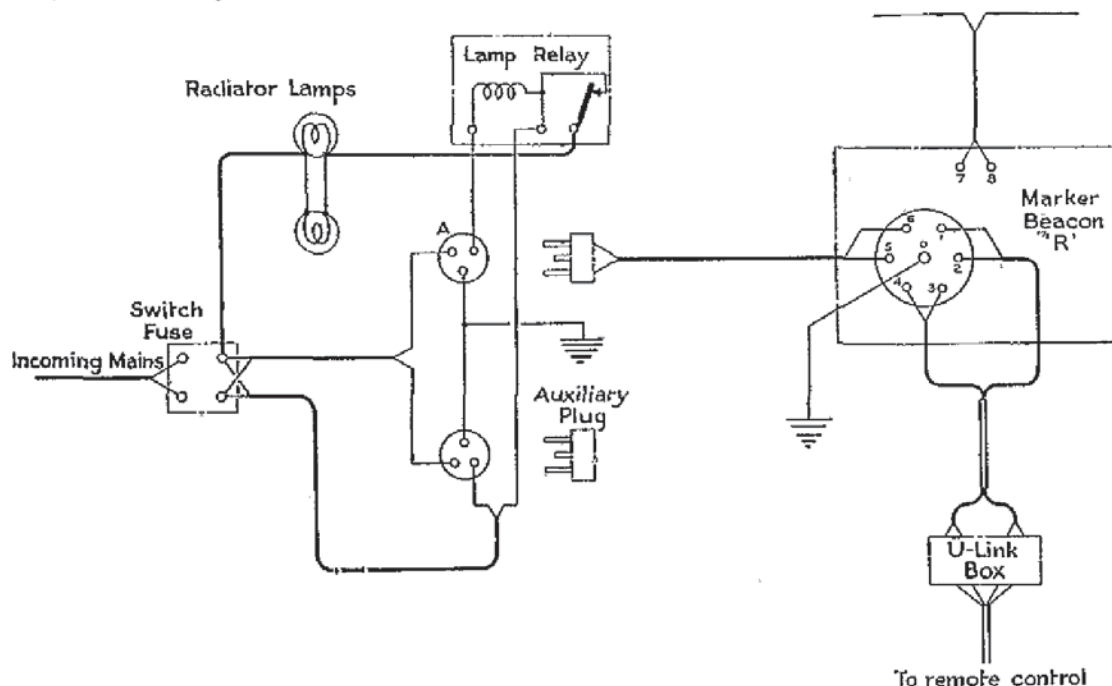


FIG. 61.—Marker beacon, installation wiring.

113. The neutralising condenser C_{14A} is adjusted with an insulated screwdriver, but its setting is not critical because the anode circuit is tuned to a frequency which differs from that applied to the grid-cathode circuit. When the tuning condenser C_{15A} is rotated backwards and forwards across its correct setting, the crystal stage grid current meter M_{1A} will generally kick at the resonance point of the upper sideband. Correct neutralisation is effected by turning the neutralising condenser clockwise or counter-clockwise until the position is found at which the minimum alteration in the reading of the meter M_{1A} occurs when the tuning condenser passes through the resonance setting. The anode current of the valve V_{3A} , read on the meter M_{3A} , should lie between 13 and 17 mA. when the neutralisation and tuning operations are completed. Great care in the selection of the correct frequency is necessary when tuning, as the output frequency of the transmitter is dependent upon it.

114. When the R.F. modulator valve V_{2A} is in operation, detuning the crystal stage or removing the crystal may not result in a zero reading on the crystal-oscillator grid current meter. This is because the output of the R.F. modulator is coupled to the grid of the crystal-oscillator by the crystal feed-back condenser, C_{10A} .

115. As a preliminary to aligning stage 3 it may be considered necessary to neutralise the stage at the crystal oscillator frequency. The grid bias resistance R_{3E} should first be adjusted until the anode current of the valves V_{4A} and V_{5A} , as read on the meter M_{4A} , lies between 40 and 50 mA. For the purposes of this measurement the anode circuit of stage 3 must be detuned by adjustment of the tuning condenser C_{20A} . The R.F. modulator valve V_{2A} should then be removed and the mixer, stage 2, tuned to the crystal frequency as previously described. The setting

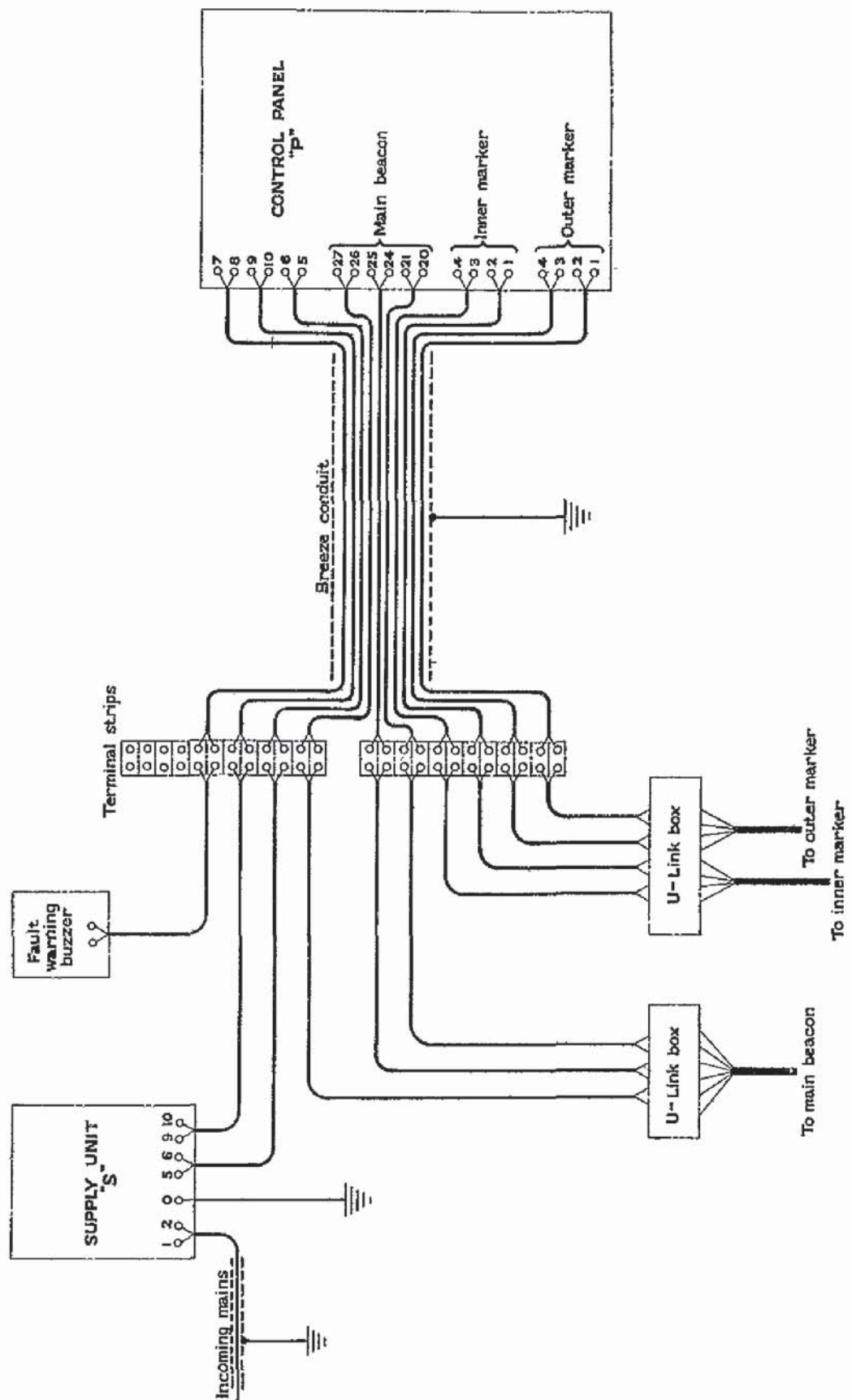
of the mixer tuning condenser C_{15A} corresponding with minimum current reading on the meter M_{3A} may not be identical with that previously noted, because the setting is dependent on the neutralisation of stage 2. The stage 3 tuning condenser C_{20A} should now be rotated until a pronounced dip in the anode current indicated by the meter M_{4A} shows that this stage is tuned to the crystal frequency. The spindle of the neutralising condensers, C_{18A} and C_{19A} , which projects through the panel between the meter M_{4A} and the tuning condenser of stage 3, should now be turned a few degrees at a time by means of an insulated screwdriver. Between each movement of the neutralising condenser, the stage 3 tuning condenser is moved backwards and forwards while anode current fluctuations are examined by means of the meter M_{3A} . The correct setting for the neutralising condenser is attained when the anode current fluctuations occurring when the tuning condenser passes the resonance position are a minimum. Having neutralised stage 3 at the crystal frequency and noted the final setting of the tuning condenser, the valve V_{2A} may be replaced and the mixer tuned to the upper sideband frequency, as explained previously. Stage 3 should then also be tuned to this frequency by moving the tuning control in such a direction as to increase the scale reading, until a second decrease in the anode current is observed. This point should occur within 20 scale degrees of the crystal frequency setting.

116. The neutralisation at the operating frequency may then be completed. It is first necessary to switch off the transmitter and to remove the rear cover of unit E. After disconnecting the lead from terminal 49, a 0-100 mA. D.C. meter should be connected to the lead and to the terminal. Long leads should be used to make this connection, so that the meter may be read from the front of the transmitter. The valves of stages 4 and 5 should be fitted in position and connected up, care being taken that the anode and grid leads are adequately separated, and firmly connected. The transmitter should then be switched ON, the switches S_{4F} and S_{1H} being similarly operated. A deflection will be observed to occur on the additional meter, indicating that R.F. drive is being applied from stage 3 to the grids of the valves of stage 4. Stage 3 should then be finally neutralised by rotating the tuning condenser backwards and forwards across the tuning point while watching the meter M_{4A} and also the additional meter. The correct position of the neutralising condenser is that at which the current increase indicated by the additional meter reaches a maximum exactly as the current indicated in the meter M_{4A} reaches a minimum. The needle of the meter M_{4A} should lie between the red lines on its scale at the minimum of the tuning dip. If it is not, a slight adjustment of the resistance R_{11A} should be made. This completes the alignment of section A.

117. The push-pull amplifier of stage 4 may be neutralised with its false panel in position because access to the ganged neutralising condensers is obtainable through an aperture provided therein. A special neutralising tool is provided for turning the spindle of the condensers. The alignment of stage 4 includes adjustment of the coupling coil between stages 4 and 5. It is first necessary to adjust the grid bias of the valves V_{1B} and V_{2B} . With the switch S_{5G} OFF, S_{4F} and S_{1H} ON and S_{6E} NORMAL, the anode current of the valves, as read on the meter M_{1B} should be between 60 and 75 mA. If necessary, the grid bias should be adjusted by means of the resistance R_{1B} , access to which is obtained by withdrawing unit E of the transmitter. Stage 4 is then neutralised without H.T. applied and without audio-frequency modulation. The transmitter is switched on in the normal manner except that the switches S_{1H} , S_{2H} and S_{8D} should be in the OFF position. The additional meter used in the alignment of stage 3 will again be required connected in the same manner.

118. The anode coupling of stage 4 is set to zero by unlocking the control and rotating the knob above the locking device, and the neutralising condensers are set to minimum capacity. A reading of 30-40 mA. should be shown on the additional meter due to the drive from the preceding stage. By slowly rotating the tuning condenser C_{6B} , a setting will be found where there is a sudden decrease in the grid current indicated by the additional meter. While the anode tuning condenser is slowly rotated backwards and forwards through this setting, the neutralising condenser should be gradually turned in a clockwise direction. The correct setting for the neutralising condenser is that at which rotation of the tuning condenser produces no change in the reading of the additional meter. Very gradual adjustment of the neutralising condensers is necessary while finding this setting, at which the stage is correctly neutralised. On closing the switch S_{1H} the anode current of stage 4 as read on the meter M_{1B} should be approximately 80 mA. when the anode circuit is tuned to resonance, and should rise to between 110 and 130 mA. if the stage is detuned.

119. The coupling coil of the output transformer T_{1B} should be adjusted to between 3 and 4



REMOTE CONTROL INSTALLATION WIRING

FIG. 62

FIG. 62

divisions as read on the scale, and the condenser C_{8B} retuned to give the minimum anode current, which should lie between 100 and 110 mA. At the same time the grid current of stage 5, as read on the meter M_{1C} , should rise.

120. The preliminary setting of the anode current of stage 5 is effected with the switches S_{8D} and S_{1H} in the OFF position, the switches S_{4F} and S_{3H} in the ON position, and the switch S_{8E} in the NORMAL position. The grid bias resistance R_{3R} should initially be in the maximum position, but should be adjusted until the anode current, as read on the meter M_{2C} is exactly 200 mA.

121. Before proceeding with neutralisation, the switch S_{2H} should be set in the OFF position, and the rear neutralising condenser C_{5C} of stage 5 set at approximately one-quarter of its capacitance. The left-hand window of the front false panel of section C should then be removed by unscrewing the fixing nuts behind it, and the false panel replaced, together with the rear panel and those of section B. The switch S_{1H} should then be set to the ON position and the grid current of stage 5 should rise to between 30 and 35 mA.

122. Using the special neutralising tool, inserted through the window opening, the front neutralising condenser, C_{6C} , of stage 5 should then be adjusted while rotating the stage 5 tuning condenser C_{7C} above and below the correct setting for resonance. The adjustment should then continue until the alteration of the grid circuit of stage 5 consequent on the rotation of C_{7C} through its resonance position is a minimum. The setting of the rear neutralising condenser C_{5C} should then be slightly altered and the rear false panel of the section replaced; the front condenser C_{6C} should then be readjusted as before. The whole procedure should be continued until no perceptible alteration of the grid current, indicated in the meter M_{1C} , is observed when the tuning condenser C_{7C} passes through the correct tuning point. The settings of the two neutralising condensers C_{5C} and C_{6C} should then be approximately the same. If there is any great discrepancy between their settings, the procedure should be repeated.

123. The switch S_{8E} should then be set to the TUNING position, and the anode coupling of stage 4 increased, retuning the tuning condenser C_{8B} as required. The grid current of stage 5 should thus be adjusted to 30 mA. The switch S_{2H} should then be set to the ON position, and the stage 5 anode circuit tuned by means of the condenser C_{7C} . If the crest of the grid current does not coincide with the minimum of the anode current when the tuning condenser C_{7C} is moved through the tuning position, the front neutralising condenser C_{6C} should be readjusted until this condition is fulfilled. The valves V_{1C} and V_{2C} should glow equally brightly.

124. The AERIAL COUPLING control should then be set to read three divisions on the scale, and the anode circuit of stage 5 should be retuned. After setting the switch S_{8E} to the NORMAL position, the anode coupling of stage 4 should be decreased, retuning the anode circuit by means of the condenser C_{8B} , until the grid current of stage 5, read on the meter M_{1C} , is reduced to 10 mA. The anode current of stage 5 should then lie between 550 and 600 mA. The AERIAL TUNING condenser C_{8C} should then be adjusted to give maximum aerial current reading on the meter M_{2C} , and the condenser subsequently adjusted to yield the minimum anode current. The aerial current, read on the meter M_{1J} , should be between 3.0 and 3.5 amps.

125. The switch S_{8D} should be set into the ON position and the MODULATION VOLTAGE control R_{1D} adjusted to indicate a voltage of between 70 and 80 volts on the meter M_{1D} . An increase of modulation voltage should increase the aerial current. The maximum increase of aerial current corresponding to a reading of about 75 volts on the meter M_{1D} should amount to 18 per cent. of its unmodulated value.

126. If the aerial current *decreases* with increase of modulation voltage, it is necessary to check that the grid current of stage 5 increases with the modulation voltage. If this is so, the aerial coupling should be slightly increased, and the aerial and anode circuits of section C should be retuned. The coupling should be increased until the transmitter "modulates up," that is, until the aerial current increases with modulation. Should the grid current of stage 5 also decrease with increasing modulation, a similar readjustment of the coupling and tuning of the anode circuit of stage 4 is necessary. The correct values of the modulation voltage, and of the aerial current are indicated by the red lines on the dials of the meters.

127. If it is necessary to renew the crystal, care should be taken that the transmitter is aligned at the correct frequency. Sufficient indication of this should normally be given by the fact that the tuning positions of all stages unaffected by the renewal should remain unchanged.

128. The crystals used may exhibit several modes of oscillation, and show resonant peaks of grid current at more than one tuning position of the crystal-anode tuning condenser. It is therefore necessary to use the minimum feedback possible, and to check the output frequency by means of the oscillator unit, type 12, as described in another section of the present publication.

129. *Aerial alignment.*—The correct functioning of the main beacon transmitter is dependent on the alignment of the aerial and of the reflectors, and if any damage to the aerial, due to any cause, is suspected, the alignment should carefully be checked by the use of a test set, type 6, which is described in another section of the present publication.

130. The framework supporting the aerial and the reflectors should be in a vertical plane, perpendicular to the Q.D.M. line joining the marker beacons to the centre dipole. The centre dipole should be vertical, the length of the upper and lower members in inches respectively being 2,660 and 2,540, divided by the operation frequency in Mc/s: the reflectors should also be vertical, and fixed as shown in fig. 42 over the outer vertical members of the framework. The aerial relay operating current should be adjusted to exactly 150 mA, by means of the resistance R_{6D} in unit D.

131. Before any testing operations are commenced, all metallic obstructions should be removed from the vicinity of the transmitter, except outside a radius of 100 yards to the side of the transmitter. The sectors within 15 degrees each of the Q.D.M. line both in front of, and to the rear of, the transmitter, should be entirely free from obstruction. The main testing point should be located at a point exactly 114 yards from the centre dipole aerial, along the Q.D.M. line. Care should be taken that the testing personnel remain within the hut while the testing is in progress, except those engaged in field strength measurement. The transmitter must, of course, be switched off when the aerial members are being adjusted.

132. After removing both reflectors from the aerial framework, the polarisation of the radiation of the main beacon transmitter may be checked, by examining the indications of output meter of the test set, type 6, located at the testing point. The output should be a maximum when the dipole of the test set is vertical. If this is not the case, the external cabling and rigging of the transmitter aerial system should be examined to ensure that no spurious radiation is taking place. This is only normally necessary during acceptance tests.

133. The lengths of the reflector aerals, when installed, may be checked by the following method. The left-hand reflector, from the point of view of our observer looking along the Q.D.M. line with his back to the main beacon transmitter, should be rendered inoperative by short circuiting the terminals of the reflector relay coil at the junction box on the inside wall of the transmitter hut.

134. The beam width along a line at right angles to the Q.D.M. line, and passing through the testing point, should then be measured by means of the test set. The test set should be moved to and fro along this line examining the indications of the output meter. The dipole aerial of the test set should be maintained in a vertical position, and held in the same position relative to the observer's body throughout the test. The telephones should be disconnected. When moving the test set along this line, a point on each side of the testing position should be observed at which slight movement of the pointer of the output meter is perceptible during keying of the reflector. The position of these points should be marked, care being taken that the pointer deflections at both of them are equal, and their distances from the testing point should be measured.

135. The distances will normally be from 5 to 10 yards. If they are unequal, the extension pieces of the right-hand reflector should be adjusted by about $\frac{1}{2}$ inch, being increased if the measured distance to the left of the test point is the greater, or decreased if the distance to the right of the test point is the greater. The process should be repeated until the distances are identical, that is to say, until the centre of the equisignal zone lies on the Q.D.M. line. When this state of affairs is attained, the extension pieces should be screwed securely into position. If the reflectors are badly out of adjustment the equisignal zone may lie completely to one side of the Q.D.M. line.

136. The length of the left-hand reflector may be adjusted after removing the short circuit across the relay coil, by setting the HAND-AUTO switch S_{2D} into the HAND position and short circuiting the two HAND KEYING contacts on panel D. The width of the equisignal zone may then be measured as before, while an assistant is keying slow dashes on a morse key, which should be connected between terminals 9 and 45 at the back of the H.T. rectifier, section H. The

128. In order to ensure that the crystal is operating at the correct frequency, the tuning condenser for the crystal stage should be rotated throughout its full range. During this rotation, the grid current meter should exhibit one kick only, namely at the crystal frequency. If no such kick is observed, the amount of feedback should be slightly increased and the tuning condenser again rotated. This should be continued until the above condition is satisfied. If more than one kick is observed, the amount of feedback should be decreased in a similar manner. To obtain the final setting of the tuning condenser, tune very carefully for maximum deflection of the grid current meter, and then decrease the grid current by approximately 10 per cent. by rotating the dial to a lower scale reading.

transmitter should be switched off to make the required connections, then switched in again for the purposes of the test. The left-hand reflector should be shortened or lengthened according as to whether the width of the equisignal zone to the left of the test point is greater or less than that on the right of the test point. Next, recheck the adjustment of the right-hand reflector. When the widths are equal, the reflector should be locked, and the transmitter connections restored to normal. The total width of equisignal zone will be approximately 8 yds.

137. On completion of the aerial alignment, the test set should be moved about within the equisignal zone while listening on the telephones. If any key clicks are heard when the transmitter is operating normally, the reflector alignments should be checked individually again; if no discrepancy is discovered, the aerial relays should be renewed and the alignment repeated.

Alignment of marker beacon transmitter

138. As a preliminary to aligning the marker beacon transmitters, it is necessary to remove them from the hut, and, after removing the front cover and assembly screws, to withdraw the front units. The crystal and all of the valves should be inserted in their correct positions except when modifications are necessary as specified for particular testing operations. Terminals 5 and 6 of the cable entry should be connected to a suitable 50 c/s A.C. supply, and the switch S_{2R} and the connection of the transformer T_{2R} should be set to correspond to the supply voltage. The front and rear units of the transmitter should be connected together by means of the flexible leads (Stores Ref. 10H/344 and 10H/345) supplied with the equipment. The switches S_{5R} and S_{6R} should be set in the ON positions, and the switches S_{1R} and S_{3R} in the LOCAL and TUNE positions respectively.

139. *Crystal oscillator.*—Before aligning the crystal oscillator circuit, it is necessary to remove the R.F. modulator unit, and to remove the H.T. supply from the valves V_{3R} , V_{4R} and V_{5R} by disconnecting one lead from each of the meters M_{1R} and M_{2R} . The condensers C_{7R} and C_{8R} should then be set in the minimum position by means of an insulated screwdriver inserted through the apertures in the panel behind the R.F. modulator, and the neutralising condenser C_{11R} should similarly be set to its minimum value. Access to this control is obtained through the aperture in the rear panel of the stage 3 compartment.

140. After switching the transmitter ON, and allowing the valves 30 or 60 seconds to warm up the condenser C_{9R} should be rotated by means of the special tool provided, while watching the pointer of the meter M_{4R} . If no sudden increase in grid current is observed for any setting of the condenser C_{9R} , the feedback control condenser C_{7R} should be rotated through a few degrees, and the test repeated. The final position of the condenser C_{7R} should be such that the grid current of the valve is zero for all settings of the condenser C_{8R} , except those adjacent to the resonance setting, when the current should increase abruptly. The final setting of the condenser C_{8R} should correspond to a capacitance slightly greater than that needed for resonance, and should be such as to reduce the grid current to approximately 90 per cent. of its peak value. The condensers should be adjusted in a clockwise direction only, and after tuning the condenser C_{8R} it should be turned further clockwise to effect the necessary grid current reduction.

141. If either the mixer valve or either of the output amplifier valves are changed, it is necessary to neutralise the circuits at the crystal frequency. To neutralise the mixer stage the front and rear units of the transmitter should be separated, and connected together by the flexible leads. After tuning the crystal stage the transmitter should be switched on as described for tuning the crystal stage, the meters M_{1R} and M_{2R} and the R.F. modulator unit being disconnected. The neutralising condenser C_{11R} should first be set at the minimum capacity. Neutralising is carried out by the method described for the alignment of the main beacon transmitter, by adjusting the neutralising condenser until the least possible alteration in the grid current of the valve V_3 is indicated by the meter M_{1R} when the condenser C_{12R} is tuned to resonance at the crystal frequency. The meter M_{1R} should be reconnected, thus applying H.T. to the anode of the valve V_{3R} . The minimum anode current reading when the anode circuit is correctly tuned, should be approximately 25 to 30 mA, and the grid current not less than 2 mA. The anode current, with the anode circuit detuned, should lie between 30 and 35 mA.

142. The valves V_{4R} and V_{5R} may be neutralised after alignment of the mixer stage at the crystal oscillator frequency, as described in the previous paragraph. Having set the neutralising condensers C_{19R} and C_{21R} to the minimum capacitance, these are adjusted as before, until their setting is such that no alteration in the current indicated by the meters M_{1R} or M_{4R} is observed

as the condenser C_{21R} is tuned through the resonance position. The disconnected lead is then replaced on the meter M_{2R} , thus applying H.T. to the valves V_{4R} and V_{5R} , when the anode current indicated should lie between 45 and 55 mA. when the anode circuit is tuned to resonance, and between 70 and 80 mA. off resonance. The readings of the dials of the tuning condensers C_{12R} and C_{21R} should then be noted and the R.F. modulator unit replaced.

143. After replacing the R.F. modulator unit in position, the tuning control is adjusted by reference to the calibration chart provided, to a frequency corresponding to the difference between the transmitter frequency, 38.0 Mc/s, and the crystal frequency. For example, if the crystal frequency is 35.80 Mc/s, the R.F. modulator should be set to a frequency $38.0 - 35.80 = 2.20$ Mc/s.

144. The valve V_{2R} in the crystal oscillator stage should be removed, and the transmitter switched on. The grid current of the mixer stage caused by the R.F. modulator should then be observed on the meter M_{1R} . This should lie between 60 and 90 per cent. of the grid current previously recorded for the crystal drive alone.

145. The valve V_{2R} should be replaced in position, and the transmitter reassembled in its case. The grid current reading on the meter M_{1R} should lie between 1.6 and 1.9 times its value when the crystal drive alone was applied. The mixer stage may then be tuned to the upper sideband frequency, which should be selected by a method similar to that described for the main beacon transmitter. The correct setting of the tuning condenser C_{12R} should be approximately 30 scale divisions lower than that previously observed for the crystal drive alone, and should correspond to maximum decrease in the anode current read on the meter M_{1R} . This decrease should be less pronounced than that observed at the setting corresponding to the crystal frequency. The condenser C_{21R} should then be adjusted to tune the output amplifier. The correct condenser scale reading, which should correspond to a maximum decrease in the anode current, as indicated by the meter M_{2R} , will be about 30 degrees lower than that corresponding to the crystal drive alone. The aerial should then be connected to the appropriate socket, and the AERIAL COUPLING control adjusted to a maximum. The condensers C_{21R} and C_{23R} should then be retuned, the latter to yield the maximum aerial current, read on the meter M_{3R} , and the process repeated until both adjustments are correct. The neutralising may be checked by the fact that the anode current minimum and the aerial current maximum occur at the same time when the anode tuning condenser is adjusted.

146. Modulation may then be applied by setting the switch S_{3R} to the NORMAL position. An increase of aerial current amounting to between 10 and 20 per cent. should be observed if a temporary short circuit is placed across terminals 18 and 19. Alteration of the modulation depth is obtained by alteration of the short circuiting links on the resistance R_{16R} , but this should never be necessary, as this control is adjusted by the manufacturers. Care should also be taken that the modulation frequency, selected by the links S_{4R} , and the keying frequency, selected by the wiring of the motor unit, should be appropriate to the position of the marker beacon. On completion of the tuning, set the switches S_{1R} and S_{3R} to REMOTE and NORMAL respectively.

Preliminary switching operations

147. Before the main or marker beacon transmitters can be switched on, either from the remote control position, or locally, it is necessary to check the various supply voltages, and to set all the supply controls and other switches in the correct positions. The first step is to switch on the supply at the incoming main switch.

148. The following operations should be performed at the switchboard, section M. The switch S_{1M} should first be closed, and the voltages between each of the pairs of incoming lines measured on the voltmeter M_{1M} by means of the voltmeter switch S_{4M} . The voltmeter readings with the switch in each of the three positions 1, 2 and 3 should be approximately equal (generally between 380 and 410), and should indicate that voltage to which the transformers were first adjusted. The switch S_{4M} should then be set in the OFF position, and the switch S_{2M} into the ON position.

149. At the voltage regulator, section N, the circuit breaker CB_{2N} , and the oilcock in the servo regulator should be set in the ON position, and the changeover switch S_{1N} in the REGULATED position.

150. Referring to the control unit F, the incoming A.C. voltages should be checked by means of the meter M_{1F} . With the switch S_{2F} in each of the three positions 1, 2 and 3 the voltmeter reading should be 220 volts. On completion of this test, the voltmeter switch should be returned

to the OFF position. The voltmeter switch S_{5F} should also be set in the OFF position. The main switch S_{1F} should be set in the ON position by means of the loose key, and the switches S_{3F} and S_{4F} in the ON position.

151. On the D.C. control unit E, the three voltmeter switches S_{3E} , S_{4E} and S_{5E} should be set in the OFF position, and the changeover switch S_{6E} in the NORMAL position.

152. At the modulation and control unit D, the overload release switches S_{5D} , S_{7D} and S_{8D} should be set in the ON position, and the modulation and keying switch S_{6D} also set in the ON position. The indicator switch S_{3D} should be set to NORMAL, unless the normal contact wheels are in need of replacement. The service switch S_{2D} should be set to AUTO unless both sets of keying wheels are damaged, when it should be set to HAND, when it will be necessary for the operator to plug a telegraph key into the HAND KEYING socket and perform the keying operation manually. The monitoring switch S_{4D} should be set to REMOTE or to LOCAL according to requirements. In general, the setting is REMOTE unless for any reason, such as testing, or breakdown of the remote control circuits, LOCAL monitoring is desired, when the switch must be held in the LOCAL position.

153. The controls on the rectifier units G and H should be set in the ON position, namely the five switches S_{1G} , S_{2G} , S_{3G} , S_{4G} and S_{5G} , which control the fan and the four low-voltage circuits, namely 6, 25, 250 and 350 volts respectively, and the two switches S_{1H} and S_{2H} controlling the H.T. circuits for stages 4 and 5.

154. The main circuit breakers S_{5R} and S_{6R} should both be set in the ON position, and the switch S_{3A} in the NORMAL position. The REMOTE-LOCAL switch S_{1R} is set to REMOTE; if this switch is set in the LOCAL position, the transmitter will remain in operation unless the switches S_{5R} and S_{6R} are OFF. As previously stated, local starting is only resorted to for testing purposes, or in the event of breakdown of the remote control circuits.

155. After completion of the preliminary switching operations, the main beacon transmitter may be started by operation of the switch S_{1E} to the ON position. This should result in the contactor CB_{1N} assuming the ON position, and allow current to flow through the A.C. circuits of the transmitter. This current is indicated on the ammeter M_{2F} , and the lamp PL_{1E} will light. The switch S_{1E} may then be released, when, unless any fault is present, the starting circuit will remain closed through the contactor CB_{1N} and the various safety circuits, and the transmitter will be in full operation after between 40 and 60 seconds have elapsed.

156. In the event of a failure of the normal starting circuits, the transmitter may be put into operation, as an emergency measure, and under constant skilled supervision only, by operation of the switch S_{2E} to the ON position. The grid bias voltage should first be checked and the fan switches examined. The locking plate on the switch must be removed before setting. The transmitter will then remain in operation until switched OFF by this switch. When the main beacon is started locally, operation of the switch S_{1D} to NORMAL or to RECIPROCAL is necessary according to the type of operation desired.

157. The marker beacon transmitters may be switched on locally by operation of the switch S_{1R} to the LOCAL position, as stated in an earlier paragraph. Radiation will continue, after a lapse of about 40 seconds, until the transmitter is switched off locally. When any transmitter is started locally, attention should be paid to the local monitoring indicators. If these fail to give the correct indications, a reason should be sought.

Remote control

158. When the equipment is to be remotely controlled, all the preliminary switching operations must be performed at the transmitters concerned, and the switches S_{4D} in the main beacon transmitter, and S_{1R} in the marker beacon transmitters set to the REMOTE positions.

159. The main supply to the supply panel, unit S, of the remote control, must first be switched ON by means of the switch S_{1S} . The MASTER SWITCH S_{1P} can then be moved clockwise, with the indicator to the right on green side, to switch on the main beacon in the normal sense, and to start the two normal marker beacons, or in the opposite direction to switch on the main beacon in the reciprocal sense, and the reciprocal marker beacons. A sufficient pause should be made on each of the two intermediate steps of the switch to allow the ON relays of the transmitters to operate. On the third or final step, the transmitters are under the control of the switches S_{3P} , S_{4P} and S_{5P} which can therefore be used to control the transmitters individually, should this be required.

160. After the lapse of the warming up period, the normal return indications described in an earlier paragraph should be checked at the remote control unit; if this is not the case an investigation should be made as described in the paragraphs dealing with the precautions and maintenance.

Switching off

161. The main beacon transmitter may be independently controlled either locally or from the remote control position, independently of all the other transmitters in the system. The transmitter can, therefore, normally be switched off either by means of the on/off switch on unit E, set momentarily to the OFF position, or by the MAIN BEACON switch at the remote control unit, set to OFF. The switching off of the marker beacons, if they have been switched on locally, has been dealt with previously. If they have been switched on by the remote control, they may be switched off individually by operation of the appropriate switch, OUTER MARKER S_{3P} , or INNER MARKER, S_{4P} , to the OFF position, though this will set the alarm circuits in operation, and therefore mask the indication of any fault subsequently developed on the main beacon. The complete equipment may be switched off by operating the master switch S_{1P} , the central OFF position, unless, as stated previously, the emergency switch S_{1E} of the main beacon is set ON.

PRECAUTIONS AND MAINTENANCE

General

162. The indications which should be received at the remote control position, unit P, when the transmitters are switched on, and are correctly operating, are listed in the ensuing paragraphs.

163. The meter M_{2P} , which is fed *via* the control cable and unit D from the indicator unit J of the main transmitter, gives an indication that a modulated carrier current is obtained from the transmitter. Aural monitoring of the modulation output is obtained by plugging telephones into the PHONE socket and setting the PHONE CONTROL switch S_{2P} to the M.B. position. At the same time, the lamp PL_{1P} will light intermittently to indicate the NORMAL keying rhythm. If the equipment is set for RECIPROCAL working, the lamp PL_{4P} will indicate the keying in a similar manner.

164. The lamps PL_{2P} and PL_{3P} light continuously to indicate that the A.C. circuits of the inner and outer normal marker beacons are switched on. In the same manner, the lamps PL_{5P} and PL_{6P} indicate the correct operation of the supply circuits of the inner and outer reciprocal markers. The meters M_{3P} and M_{4P} yield indications that the inner and outer beacons are radiating a modulated signal. The needles oscillate in rhythm with the keying, and the meters therefore provide an indication of the keying as well as of the modulation of the output. Aural monitoring facilities are provided in each case by the use of phones plugged into the PHONE socket, the markings I.M. and O.M. of the phone control switch, indicating inner marker and outer marker respectively.

Local operation

165. The main and marker beacon transmitters, as previously described, carry meters and indicator lamps which duplicate the indications given at the remote control position. These may be used to check locally the correct operation of the transmitters, and, in the event of indication failure at the remote control position, to indicate whether the fault lies in the transmitter or in the return circuits.

166. The aerial current is monitored, as previously described, by the meters M_{1J} and M_{3D} . The modulation supply is indicated in the meter M_{1D} and the modulation in the aerial on the meter M_{2D} with the switch S_{4D} set to LOCAL. Instructions for making adjustments to the modulation strength have been given in the alignment section. Keying is indicated on the lamp PL_{2D} or PL_{4D} for normal working, the latter if the spare keying wheel is in use.

167. The lamp PL_{1R} in the marker beacon indicates the keying rhythm of the transmitter, the lamp PL_{2R} indicating that the A.C. circuits are alive. The aerial current is indicated on the meter M_{3R} , and the modulation can be monitored by means of telephones.

Supply voltages and currents

168. The average values of the anode currents of the valves in the main and beacon transmitters have been laid down in the paragraphs dealing with alignment. These values, which should be checked periodically, presuppose that the supply voltages are correct. The checking

of these voltages is essential when aligning the transmitter, and also desirable at regular intervals. The methods of measurement of these voltages, and their correct values, are given in the ensuing paragraphs. The voltages must be read with the transmitter in operation.

169. The heater voltage for the valves of units A and J should read 6.3 volts on the meter M_{1E} when the switch S_{3E} is operated to the left. The same meter, with the associated switch operated to the right, reads the voltage of the D.C. supply for the aerial relays, the correct indication in this case being between 28 and 29 volts.

170. With the switch S_{4E} operated to the left, the grid bias supply voltage may be checked on the meter M_{2E} , which should indicate 250 volts. The same meter should indicate 350 volts when the switch is operated to the right, to measure the H.T. voltage for the valves of unit A.

171. To measure the H.T. voltages for units B and C, the switch $S5_E$ should be operated to the left and right respectively. The indications read on the meter M_{3E} should be 1,500 volts and 2,500 volts approximately.

172. Should any of these voltages differ by more than $2\frac{1}{2}$ per cent. from the setting marked by the red line on the metal theappings of the transformers feeding the rectifiers should be adjusted as described in subsequent paragraphs. Due to ageing of the rectifier units, a decrease in output voltages amounting to between $2\frac{1}{2}$ and 5 per cent. is to be expected after 10,000 hours of operation, and a further similar decrease is possible after a further 10,000 hours.

173. The L.T. supplies for the valves of stages 4 and 5 are indicated on the meter M_{3F} with the switch S_{6F} set in the appropriate positions. The correct voltages should be 7.5 and 10.5 respectively. If the latter reading is incorrect, it may be adjusted by moving the slider of the rheostat R_{1F} . The stage 4 L.T. supply voltage may then be adjusted by means of the rheostats R_{2F} and R_{3F} which are connected in parallel. As the adjustments are to some extent interdependent, it is desirable to adjust the stage 5 voltage first, and the stage 4 voltage subsequently, and thereafter to readjust both in the same order if this is necessary. Care is necessary that the residual values of the resistances R_{2F} and R_{3F} are approximately equal, as otherwise that with the lower resistance may carry an excessive proportion of the current, and will consequently become overheated and possibly damaged.

174. The L.T. voltage of the marker beacons with all valves alight may be measured with an A.C. voltmeter connected across terminals 16 and 17 of any of the units. The R.F. modulator unit may be withdrawn to facilitate the connection of the voltmeter without dismantling the complete transmitter. The voltage should be 6.3 volts approximately. If the voltage is incorrect, it may be adjusted by means of the primary tapplings on the transformer T_{2R} . This should not in general be necessary if the mains voltages are of their rated values, unless the primary tapplings were incorrectly selected in the first instance. The H.T. voltage, read on the meter M_{6R} should be 450 volts, and may be adjusted, as previously described, by means of the secondary H.T. tapplings on the mains transformer. Ageing of the rectifiers is to be anticipated, and corrected, on the lines laid down for the rectifiers in the main beacon transmitter.

175. *Transformer adjustments.*—Adjustments to the transformer T_{1G} supplying the 6-volt rectifier may be made as follows. With a line voltage of 220 across the primary, the normal secondary voltage is 8 : 1, each of the terminals a, b and c being linked to its associated terminal 5, and a_0 , b_0 and c_0 to the terminal 4. By connecting terminals a_0 , b_0 and c_0 to terminal 3, a voltage increase of $2\frac{1}{2}$ per cent. is obtained, successive increments of $2\frac{1}{2}$ per cent. being obtained by the use of the terminals 2 or 1.

176. Additional voltage increases of $7\frac{1}{2}$ per cent. per step are obtained by altering the connections of a, b and c to terminals 6, 7 and 8; thus giving a total increase of 30 per cent. if required.

177. The arrangement of the terminal board of the transformer T_{2G} is similar. The normal voltage, with the terminals a_0 , b_0 , c_0 connected to terminal 3 and a, b, c to 5, is 21 volts. By altering the latter terminal connections in succession to 6, 7 and 8, voltage increases of $2\frac{1}{2}$, 5 and $7\frac{1}{2}$ per cent. are obtained. The connection of terminals a_0 , b_0 and c_0 to terminal 1 or 2 increases the normal voltage by $7\frac{1}{2}$ or 15 per cent. while connection to terminal 4 decreases it by $7\frac{1}{2}$ per cent. respectively.

178. A similarly arranged terminal board controls the secondary connections of the transformer T_{3G} . With terminals a_0 , b_0 and c_0 connected to terminal 2, a secondary voltage of 208 is

obtained with terminals a, b and c linked in position 5. Increases of $2\frac{1}{2}$, 5 or $7\frac{1}{2}$ per cent. are obtained by altering these latter linkages to 6, 7 or 8 respectively. The output voltage may be increased by $7\frac{1}{2}$ per cent. by connecting terminals a_0 , b_0 and c_0 to terminal 1, or may be decreased by $7\frac{1}{2}$ or 15 per cent. by connecting them to terminal 3 or to terminal 4 respectively.

179. The secondary voltage of the transformer T_{AG} is normally 280, with terminals A, B and C at 6, and A_0 , B_0 and C_0 at 4. As the connections of the latter terminals are altered successively to 3, 2 and 1 the output voltage is increased by $2\frac{1}{2}$, 5 or $7\frac{1}{2}$ per cent. Alternatively, connecting terminals A, B and C to 5, 7 or 8 respectively, effects a decrease of $7\frac{1}{2}$ per cent. or increases of $7\frac{1}{2}$ or 15 per cent. in the normal voltage.

180. The terminal boards of the transformer T_{1H} in the high tension rectifier unit are similarly arranged, the output terminals a, b and c being connected to numbered terminals. When tappings 4, 2 and 8 are used, the secondary voltage is 1,210, increased by $2\frac{1}{2}$, 5 and $7\frac{1}{2}$ per cent. by altering the latter tap successively to 7, 6 and 5. Voltage increases of $7\frac{1}{2}$ or 15 per cent. or a decrease of $7\frac{1}{2}$ per cent. respectively are obtained by the use of tapping 3, 4 or 1 are used instead of 2.

181. The output voltage of the 2,500-volt transformer T_{2H} is similarly adjusted. The normal secondary voltage using primary tappings 3 and 8, is 2,043 volts. Using terminals 3 and 7 effects an increase of $2\frac{1}{2}$ per cent., equal percentage increments being obtained when the latter tappings are altered successively to 6 and 5. To decrease the normal voltage by $7\frac{1}{2}$ or 15 per cent., terminals 2 or 1 respectively are employed instead of 3. The terminals numbered 4 effect an increase of $7\frac{1}{2}$ per cent.

182. The primary windings of the transformers T_{2R} in the marker beacon transmitter are fitted with six tapping terminals. If the mains voltage is 110, 200, 220, or 240 one of the incoming mains is connected to terminal 0, the other to the terminal whose marking corresponds with the mains voltage. For mains voltages of 115, 205, 225 or 245, one main is connected to terminal 5, the other to terminal 110, 200, 220, or 240 respectively. The L.T. secondary winding, whose terminals are marked 6v. SEC.2, together with all other plugs forming connections between this unit and the A.F. modulator unit in front of it, are mounted on terminal strips. The secondary H.T. winding, which is connected to the four-section selenium rectifier $RECT_{1R}$ mounted at the top of the unit is provided with 10 tappings. The marking of five of the terminals, 467 volts, 490 volts, and 512 volts denotes the output voltage between the terminal and terminal 0. The voltage can be decreased by approximately 12 volts, or increased by 12, 24 or 36 volts approximately, by employing terminals - $2\frac{1}{2}$ per cent., + $2\frac{1}{2}$ per cent., + 5 per cent., or $7\frac{1}{2}$ per cent. respectively in the place of terminal 0.

183. The primary winding terminals of the terminal board of the transformer T_{1S} in the remote control supply unit, are numbered to correspond with the supply voltages exactly as described in connection with the marker beacon transmitters. The secondary terminals are marked 0 and 80 volts, with auxiliary tappings in steps of 2 volts from - 8 volts to + 8 volts for use instead of terminal 0, and from - 2 volts to + 4 volts for use instead of terminal 80, thus giving a range of voltage adjustment from $80 - 8 - 2 = 70$ volts to $80 + 8 + 4 = 92$ volts.

Maintenance of relays and motors

184. Attention should be paid to the following details at the main beacon at fairly frequent intervals.

- (i) The contacts of REL_{2G} , the delayed switching relay, should be inspected and cleared, and any pitting of the contact should be removed by means of a smooth file.
- (ii) The caps of the grease cups of the fans FAN_{1R} and FAN_{1G} in the supply and L.T. rectifier units should be tightened by giving the caps one or two turns in a clockwise direction. When necessary, the cups should be refilled with a grease such as Price's Belmoline C grease.
- (iii) The contacts of the contactor CB_{1N} should be inspected, cleaned, and if necessary filed to remove pitting.

185. The gear box and bearings of the motors MTR_{1R} in the marker beacon supply units should be periodically examined and repacked with a suitable lubricant, such as Duckham's grease No. Z. 5935. The bevel gearing of the induction regulator REG_{2N} in the main beacon should also be inspected, and smeared with a grease of similar grade to that specified in the previous paragraph.

186. The gear box of the motor unit in unit D of the main beacon should occasionally be drained by removing the two plugs in the rim, and refilled with a small quantity of light machine oil after replacing the lower plug. The grease cups should be filled with grease as described above, and screwed up fairly tightly.

187. The regulator tank of the servo motor REG_{IN} in the main beacon should occasionally be drained of oil by unscrewing the lower plug, then rinsed with fresh oil which should also be drained. The plug should then be replaced, and the tank refilled until the level rises half-way up the observation window. The regulator should then be run for 15 minutes, with the oil tap in the OFF position, before being put back into service.

Location of faults.

188. In the ensuing paragraphs an account is given of the method of tracing possible faults in the equipment which may occur in service.

189. *Remote control.*—If no return indications are received when about 60 seconds have elapsed after switching the transmitters on at the remote control position, the switches S_{3P} , S_{4P} and S_{5P} under the lid in the lower panel containing the alarm lamp PL_{7P} should be examined. If these are ON, and the alarm lamp and buzzer do not function, the mains supply at terminals 1 and 2, in the supply panel S should be checked with an A.C. voltmeter.

190. If the mains supply is satisfactory, the fuses F_{1S} and F_{2S} should be examined. If any of these has blown, a small coloured disc is visible in the centre hole in the cap of the fuse. The cause of a blown fuse may be investigated as follows:—

- (i) Check the insulation resistance of the smoothing condenser C_{3S} and choke L_{1S} in the supply panel.
- (ii) Measure the insulation resistance of the wiring of the remote control unit P at the input terminals 5 and 6, and also the input resistance between these terminals.
- (iii) Check the forward and backward resistance of each of the four arms of the rectifier $RECT_{1S}$ in the supply panel.
- (iv) Check the insulation resistance of the windings of the mains transformers T_{1S} and the insulation resistance of the wiring.
- (v) Check the insulation resistance of the condensers C_{1S} and C_{2S} .

191. If, however, the fuses are intact, a discontinuity in the supply wiring is to be suspected, and a measurement of the D.C. output voltage across terminals 5 and 6 should be made, and followed by similar successive measurements across the terminals of the resistance R_{1S} and across the D.C. terminals of the rectifier $RECT_{1S}$. If no D.C. output is obtained in any of these measurements, the A.C. voltage should successively be checked across the secondary terminals and the primary terminals of the transformer T_{1S} , across the chokes L_{2S} and L_{3S} and across the input and output terminals of the switch S_{1S} . These measurements should indicate whether there is a disconnection in the primary or secondary windings of the transformer, in the chokes, in the fuses, or in the switch contacts, and the cause of these should be investigated.

192. On the other hand, if the D.C. voltage is observed across the rectifier terminals, a disconnection in the fuse F_{2S} or in the choke L_{1S} will be indicated. If the voltage is incorrect, this may be adjusted either by reconnecting the primary winding of T_{1S} to suit the mains voltage, or by resetting the secondary tapplings to obtain a D.C. output of 60 volts. If certain of the indications are received at the remote-control position, but others are not, the fault may lie either in the transmitter concerned or in the remote control position, and it is therefore desirable to check the transmitter operation locally before investigating the indication circuits at the remote-control position.

193. If the transmitters whose return indications are faulty are found to be operating correctly, the starting circuits are in order and the return indication circuits need investigation. If the voltages measured at terminals 1 and 2 (2.5 volts A.C.) and at terminals 3 and 4 (50 volts A.C.) of the marker beacon, or across terminals 20 and 21, and either 24 and 25, or 26 and 27 of the main transmitter are in order, the faults are to be sought in the remote control panel. In the case of a lamp indication failing, the first step is to try renewing the lamp itself. Otherwise a systematic continuity test of the wiring and components of the affected indication circuit in the remote control unit is necessary, with especial attention to the relay contacts.

194. If the transmitter affected is observed not to be in operation, the local starting circuits should be checked. In the main transmitter this may be achieved by means of the switch S_{1E} , and on the marker beacons by manual operation of REL_{1R} by depressing the armature, which is made accessible by removing the lid on the front panel of the modulator unit. If the relay starting circuits of the transmitters are found to be in order, the corrections and continuity of the relay windings and the associated circuits at the transmitters should be investigated. The interconnecting cables between the transmitter and the remote control position, should be tested, and if these are in order, a systematic continuity test of the starting circuit in the remote control unit should be undertaken.

195. *Marker beacons.*—If the marker beacon starts when the relay REL_{1R} is operated manually, before investigating the remote control unit, it is advisable to inspect and clean the pins and sockets 1 and 2 of the input plug. The resistance of the coil of the relay should be measured and compared with the value marked on the coil, and the value of the resistance R_{19R} also measured.

196. If the manual operation of REL_{1R} fails to start the transmitter the mains supply should be checked and the setting of the automatic switches S_{5R} and S_{6R} also. If these are OFF, the cause should be investigated and the insulation of the transmitter circuits tested, before they are reset in the ON position, if the release is suspected to have arisen automatically. The switch S_{1R} should then be set in the ON position. If the transmitter then starts to operate, the fault will lie in the contacts of the relays REL_{1R} or REL_{2R} , which should be inspected. If the switch S_{1R} fails to start the transmitter, the relay REL_{3R} should be operated manually. If this measure is successful, a test of the winding of the relay, and of the circuit of the resistances, R_{12R} , R_{20R} and the rectifier $RECT_{2R}$ will be necessary. If the measure is unsuccessful, the A.C. mains supply should be tested with an A.C. voltmeter applied across terminals 5 and 6 of the transmitter input plug, and the pins and sockets cleaned if necessary. The effect of making a temporary bridge across the terminals of the switches S_{5R} and S_{6R} should then be tried, if the supply is satisfactory. This is unnecessary if the correct voltage appears across the output terminals of these components. The contacts of the relay REL_{2R} should be checked. These should be closed, and the relay operated.

197. If the relay REL_{3R} operates when the transmitter is switched on, but the pilot lamp PL_{2R} does not light, after testing the lamp, the contacts of the relay should be inspected, and cleaned and adjusted if necessary. If the correct A.C. voltage is then obtained at terminals 26 and 28 of the supply unit, the continuity of and the connections to the primary of the transformer T_{2R} should be examined, and also the plugs and sockets 26, 27, 28 and 29.

198. If the H.T. voltage is low or absent when the transmitter is switched on, the L.T. voltage should be checked with an A.C. voltmeter across terminal 22 and 24. If this is also low or absent, the mains circuit should be investigated as previously described. If the L.T. voltage is correct, the H.T. circuits should be investigated. If the H.T. voltage is low, the transformer output voltage should be measured.

199. If there is any discrepancy between this and the rectified voltage, the forward and backward resistances of the arms of the rectifier $RECT_{2R}$ should be measured, and the insulation and load resistance of the output circuit also measured. In particular, the insulation resistance of the condensers C_{33R} , C_{32R} , and the resistances of the choke L_{12R} , and the connections of the H.T. circuit should be examined. If there is agreement between the A.C. input and the D.C. output of the rectifier, the voltage should be corrected by means of the secondary transformer tappings.

200. If the H.T. voltage is absent, the fuse F_{1R} should first be examined. If this is seen to have blown, the output circuit should be tested to localise the probable short circuit and the valve V_1 tested in case it has developed a fault. After checking the output voltage at the rectifier output terminals, and testing the rectifier and transformer H.T. circuits if no measurable voltage is developed, a continuity test of the D.C. H.T. circuits should be undertaken, by short circuiting the fuse F_{1R} and testing the resistance of the choke L_{12R} .

201. When the L.T. voltage is suspected of being low or absent, indicated by low or zero anode currents and by high H.T. voltage, the insulation resistance between the heaters and earth should be measured. If this is low, remove the valves one at a time until the faulty valve is located. If none of the valves are at fault, disconnect the resistance R_{17R} . The valveholders should also be inspected for short circuits to earth, and the continuity of the L.T. wiring and of the plugs and sockets 22, 23 and 24 tested. If the open circuit voltage of the L.T. secondary of the transformer is inadequate, the transformer itself must be at fault.

202. Faults in the R.F. circuits may be localised by the measurement of anode and grid currents, as described in the paragraphs dealing with alignment. The effect of a new valve in the faulty stage or stages should be tried before investigating the circuits themselves. If the modulation is found to be absent when monitoring with telephones plugged into the socket SK_{2R}, the switch S_{3R} should be examined and the valve V_{7R} and its associated circuit tested. In the event of failure, the crystals should be renewed and the circuits returned, and the plugs of the R.F. modulator unit examined to ensure good contact. Cases have arisen where all normal indications have appeared, but no signals are received by aircraft, due to the transmitter being tuned to the crystal frequency.

203. If the keying fails, but the keying motor runs in a satisfactory manner, the leads at the keying contacts should be inspected and resoldered if necessary. The keying contacts should also be examined and cleaned and adjusted if they fail to close properly or if they or the guide pin are short circuited. If the motor fails to start, its connections should be examined, and the voltage at the motor block checked. In cold weather the motor will not start if the heater lamps of the installation have not been functioning. If these are inoperative, the relay needs attention.

204. *Starting circuits of the main beacon.*—If the main beacon transmitter starts locally when the switch S_{1E} is operated, but fails to do so from the remote control position, the relay REL_{2E} should be operated manually after lowering the cover on the front of unit E. If this does not start the transmitter the contacts should be cleaned and adjusted. If manual operation is successful the resistances of the winding of REL_{2E} and of the resistance R_{2E} and also the insulation resistance of the condenser C_{1E}, should then be measured.

205. If the starting circuit controlled by the switch S_{1E} is faulty in operation, the effect of setting the emergency switch S_{2E} to the ON position should be tried momentarily after switching off the H.T. to stage 5. The 250-volt supply should then be tested. If the contactor CB_{1N} is then heard to operate, the starting circuits should be investigated in the following manner:—

- (i) Inspect and clean the contacts of the off relay REL_{1E}, making sure that this relay is released and that its contacts are making.
- (ii) See that when the switch S_{1E} is in the normal or in the ON position, the contacts on the OFF side of the switch are in contact with each other. Clean and adjust these if necessary.

206. Having established that the primary starting circuit is in order, the secondary circuit should be investigated. If this is in order, the transmitter should remain switched on after the emergency switch S_{2E} is opened. If this is not the case, it is necessary to check that the switches S_{1G} and S_{3F} are closed, and that a continuous circuit exists between terminals 32A and 32B on panel F. The cover of the lower section of the voltage regulator unit should be removed, and with the supplies switched on, the contactor CB_{1N}, the relay REL_{1N} and the regulator motor circuit breaker CB_{2N} should be examined. If the relay REL_{1N} is operated, this may be due to accidental reversal of one phase connection, if the unit has been dismantled for any reason. The effect of reversing one of the phase windings should be tried, and at the same time the incoming A.C. mains should be tested as described later, to make sure that all three phases of the incoming mains are in order. The mercury switch of the relay, which should normally be made, should be examined as should the contacts of the other relays.

207. If these are in order, a continuous circuit should exist between terminals 32 and 33, provided CB_{1N} is operated. Finally, with the supplies switched off, the relay REL_{1Q} should be manually operated, and the closing of the circuit between terminals 32_B and 32_C on panel G should be checked. With the supply switched on, and the emergency switch S_{2E} also in the ON position, the operation of the relay should be examined. If it fails to operate, the 250-volt supply should be checked, and, unless this is at fault, the winding and connections of the relay should be checked. If the transmitter fails to start even when the emergency switch is operated, the A.C. supplies should first be checked, as described in the next paragraph. If these are satisfactory, the switch itself should be examined, and the winding of the contactor CB_{1N}. Note that the emergency switch should never be used without first switching off the stage 5 H.T. unless the stage 5 bias supply circuit has been proved to be in good order, to minimise the risk of damage to the valves.

208. *Supplies of main beacon.*—When a trial operation of the emergency switch S_{2E} fails to start the transmitter after having seen that all the preliminary switching operations have been

correctly performed, the incoming mains should first be tested at the switchboard M by means of the voltmeter V_{1M} . All three phases should be tested, especially if a fault has appeared at the phase failure relay REL_{1M} . If no indication appears, the fuses F_{1M} should be examined, and the voltage tested at the incoming terminals A, B, C. If no faults are found here, or in the contacts of the switch S_{1M} the voltages at terminals R, S and T should be measured, and if absent, a fault should be looked for in the contacts of the switch S_{2M} . The output of the regulator may be checked by the voltmeter M_{1F} as previously described. If this is absent, a cause should be found in the wiring between panels F and N, between M and N, or in the circuit breakers CB_{1N} and CB_{2N} of the voltage regulator. The test should be systematically continued, to terminals 1, 2 and 3, using a separate A.C. voltmeter and the wiring and contacts of the switch S_{1F} examined if necessary.

209. If the output voltage of the regulator, as measured by the voltmeter M_{1F} , differs from 220 volts, the voltage regulator should be systematically tested as follows :—

- (i) If the voltage is high immediately after switching on, but falls to its normal value later, the oil heater has probably failed, and a test should be made of the voltage across the terminals Hh. If this is absent, the fuses F_{1N} and the thermostat TH_{1N} should be examined.
- (ii) In the event of the voltage remaining at 230 volts, and if the switch S_{1N} is set at REGULATED, the pilot coil Bb should be tested for voltage, and if no voltage exists the cause should be sought in the resistance R_{1N} and its slider, and in the setting of the circuit breaker CB_{2N} which controls the oil pump. The wiring of the coil Bb and of the resistance R_{1N} should also be tested, and the resistance checked in case an open circuit has developed.
- (iii) In cases where the voltage remains constant, but of an incorrect value, the resistance R_{1N} should be adjusted until the correct output voltage is obtained.
- (iv) If the output voltage varies on load, and the switch S_{1N} is set in the REGULATED position, the oil pump is probably inoperative, and the supply should be checked at the motor terminals. Failure of the supply may be due to the circuit breaker CB_{2N} having been tripped, or to a fault in the wiring or contacts. Sudden fluctuations in voltage may be overcome by very slight readjustments of the check screw C, after loosening the locknut D.

210. When the main beacon transmitter fails to operate, although the A.C. supplies and the starting circuits have been tested and found to be in order, and the switch S_{1F} is closed, a systematic test of the D.C. voltages should be undertaken. As previously stated, a fault in the 250-volt grid bias circuit will prevent the transmitter from starting except when the emergency switch S_{2E} is used. Where any of the D.C. voltages are absent, the circuit should be systematically tested as follows :—

- (i) The setting of the main circuit breaker of the rectifier should be examined. If this is automatically released, the insulation resistance of the transformer should be tested and the backward and forward resistance of the rectifier arms measured. If the results of these tests are satisfactory, a systematic short circuit test, as described in sub-paragraph (ii) should be undertaken.
- (ii) The fuse should be examined. If this has blown, the insulation resistance of the condensers and of the wiring should be measured, and also that of the load circuits in other units of the transmitter.
- (iii) The continuity of the circuit should be tested, including the smoothing choke, and the fuse, which may have a bad contact.
- (iv) When the transmitter operates in a satisfactory manner, but no voltage indication is obtained in a circuit, the fault is to be sought in the wiring to the meter unit E and in the associated switch, resistance, and meter circuits.

211. If the output voltage is incorrect, the incoming mains should be tested at the primary terminals of the transformer. If only a single phase is supplied, the circuit breaker should be examined, otherwise the transformer windings and connections should be carefully inspected, and the tappings altered if necessary.

212. The information given in the preceding paragraphs on testing for short circuits and open circuits applies equally to the 1,500-volt D.C. circuit. It should be noted that the fuse

differs in design from those previously dealt with, and that fault indication is given by the puncturing of the label on a blown fuse. This applies equally to the fuse in the 2,500-volt supply. A failure of the 1,500-volt supply may also be caused by a fault in the delayed switching relays, though it must be remembered that the 1,500-volt supply is not normally alive until 40 seconds have elapsed after the transmitter has been switched on. The relays should be systematically tested as follows, after removing the front cover of the L.T. rectifier, unit G, and ensuring that the 10-volt A.C. supply to terminals 42 and 43 of panel F is switched on and is operative.

- (i) Operate the relay REL_{2G} , which is above the circuit breaker S_{1G} . If this does not restore the supply, the fault must lie either in the relay contacts, or in their wiring to the A.C. mains at terminals 1 and 3, to the transformer T_{1H} via terminals 5 and 6.
- (ii) After checking the operation of the relay REL_{2G} , operate REL_{3G} by hand. This relay is the uppermost of the three relays enclosed in a dust cover behind S_{1G} . If this operation does not cause the relay REL_{2G} to close, inspect the contacts of the relay REL_{3G} and the armature of REL_{2G} , and measure the resistance of the winding of the relay REL_{2G} , making sure that the 220-volt A.C. supply is applied across the winding of REL_{2G} by the operation of REL_{3G} .
- (iii) Check the 25-volt supply if this operation has not already been performed, and operate the relay REL_{4G} manually. This relay is the lowest in the tier below REL_{3G} . If, after keeping REL_{4G} in the operated position for about 40 seconds, the relay REL_{3G} does not operate, the contacts of REL_{4G} should be inspected, and also the contacts of the thermal delay. The wiring of the relays may also need attention, and also the back contact of REL_{3G} , which should be "made" until the relay is operated. The fault may also be due to misalignment of the armature of REL_{3G} .
- (iv) If the delay time differs greatly from the specified period, 40 seconds, the contacts of the thermal delay unit should be adjusted. If the relay REL_{3G} only operates momentarily after the specified delay, and afterwards releases, the retaining contacts on this relay need adjustment so that they make when the relay operates.
- (v) If the relay REL_{4G} does not operate when the 10-volt A.C. filament supply to the heaters of stage 5 is correctly delivered to terminals 42 and 43 of unit G, the rectifier $RECT_{5G}$, and the winding of the relay should be tested and the alignment of the armature checked.

213. The method of testing for failure of the 2,500-volt H.T. supply is the same as that for the L.T. circuits. If the voltage is incorrect, the setting of the switch S_{8E} should be examined. This should be set at NORMAL and the wiring and contacts of the switch should also be inspected. If these measures fail to reveal a fault, the transformer tapplings should be reset to correct the output voltage. Inspect carefully the wires from the transformer T_{2H} to the rectifier T_{2H} which are liable to breakage.

214. If the valves of stages 4 and 5 both fail to light, after checking the incoming A.C. supply and seeing that the switches S_{1F} and S_{4F} are ON, the continuity of the wiring, of the primary of the transformer T_{1F} , and of the resistance R_{1F} should be examined. Tests should also be performed, by temporarily short circuiting the contacts, to determine whether the switches and circuit breakers are faulty.

215. When the valves of stage 5 alone are affected, the existence of a fault in the 10-volt secondary winding of T_{1F} or in the wiring is to be expected. If the failure is accompanied by a very low voltage at the filaments of stage 4 the possibility of a short circuit in the 10-volt winding circuit may be envisaged. If the valves of stage 5 do not light, the supply should immediately be switched off, or the valves of stage 4 removed, as these will be damaged if excess voltage is applied to them. These valves should not be reconnected in circuit until the fault has been located and rectified.

216. Complete failure of the filament supply to stage 4 alone may be caused by an open circuit in the wiring, or in the resistances R_{2F} and R_{3F} . A sudden decrease in voltage would result from a disconnection developing in one of these components. Other faults leading to a complete failure of filament supply to this stage are an open circuit in the 7.5-volt winding of the transformer T_{1F} , or a short circuit across its terminals, which would also produce a low voltage across stage 5.

217. *Modulation and keying circuits.*—Failure of both the modulation and keying circuits together can normally be traced to the motor assembly failing to run. This may be due either to one or more of the switches S_{6D} , S_{7D} , or S_{8D} being in the OFF position. If the automatic release switches have released automatically, a reason should be sought by an insulation test of the wiring. If both these are in the ON position, their contacts should be examined, and tested by temporary short circuits across them. Failing success with any of these measures, the assembly should be removed, and the motor tested independently.

218. If the modulation supply fails, the alternator field circuit should be tested as follows :—

- (i) Check the voltage of the 250-volt D.C. supply.
- (ii) See that the switch S_{5D} is in the ON position, and if it has released, investigate the cause.
- (iii) Measure the resistance of R_{2D} to ensure that it has not developed an open circuit, and that the slider is making good contact.
- (iv) Perform a similar test on the potentiometer, R_{1D} .
- (v) Measure the resistance of the alternator field winding, and inspect all connections.

If these circuits are in order, the A.F. circuits should also be examined systematically as follows :—

- (vi) Test the resistances and insulation of the alternator winding the resistance R_1 , terminals 4 and 5 on the motor assembly, and of the primary winding of the transformer T_{2D} , and the insulation resistance of the condenser C_{3D} .
- (vii) Inspect the secondary winding of the transformer T_{2D} , and its connections *via* terminals 19 and 29 to the other panels.

219. If the indications at the remote panel are absent, and the correct aerial current is observed at the meter M_{1J} , the modulation voltage should be measured at the meter M_{1D} . If this is correct, the meter M_{3D} should be examined, together with the wiring to unit J and the transformer T_{1D} . The valve V_{1J} should be renewed if necessary. If these indications are in order, the circuits of the meter M_{2D} should be examined, and the contacts and wiring of the switch S_{4D} and its associated components.

220. Failure of all the keying indications may be due to the switch S_{2D} being set to HAND instead of to AUTO, to its contacts being faulty, or to failure of the motor unit. If neither of these faults is present, the windings of the transformer T_{3D} , which provides the supply to the indicator lamps, should be investigated, and also the contacts of the relay REL_{3D} . If one or more of the lamps PL_{1D} , PL_{2D} , PL_{3D} or PL_{4D} light when the switches S_{1D} and S_{3D} are suitably operated, the fault in the remaining lamp or lamps must lie in the lamps themselves, in the wiring of the switches S_{1D} and S_{3D} , or in the contacts of the keying wheels and their connections *via* terminals 8, 9, 10, 11 and 12 on the motor unit to the switch S_{3D} . Where the failure is restricted to one pair of lamps, either the normal pair or the reciprocal pair, the fault more probably lies either in the switch S_{1D} or in the windings or contacts of the relays REL_{1D} and REL_{2D} . These circuits should be carefully examined.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref.	Remarks.
	Blind approach transmitter equipment			
	Comprising			
10B/387	Aerial system, type 27	1		Main beacon
10B/388	Aerial system, type 28	2		Marker beacons
10L/12021	Control unit, type 14 ..	1		Marker beacon control unit P
10L/10800	Control unit, type 35 ..	1		
10B/11118	Insulator, type 38 ..	26		Aerial insulator
10B/11119	Insulator, type 39 ..	1		For coaxial cable
10A/10918	Mounting, type 113 ..	1		Anti-vibration, for T.1122
10K/11880	Power unit, type 107 ..	1		Unit S
10F/10745	Regulator, power, type 4 ..			Unit N, voltage regulator
10F/241	Relay unit, type 7 ..			Unit L, open
10F/242	Relay unit, type 8 ..			Unit K, closed
10F/10744	Switchboard ..	1		Unit M
10S/11859	Test set, type 6 ..			For testing
10D/10620	Transmitter, type T.1122 ..			Main beacon
	Consisting of			
10V/11197	Amplifier unit, type 96 ..	1		Unit B, stage 4
10V/11198	Amplifier unit, type 97 ..	1		Unit C, stage 5
10L/11200	Control unit, type 33 ..	1		Unit D
10L/11201	Control unit, type 34 ..	1		Unit E
10D/11196	Exciter unit, type 1 ..	1	Ref. in fig. 2	Unit A
	Fitted with			
10V/31	Amplifying unit, type 107	1		Stage 3
10C/10628	Choke, H.F., type 167	2	L_{10}, L_{11}	
10C/10649	Choke, H.F., type 447	3	C_{26}, C_{27}, C_{28}	0.1 μF
10A/10631	Lamp, filament	1	PL_1	Neon
10D/503	Modulator unit, type 25	1		{ Together forming oscillator unit, type 53, Stores Ref. 10V/2, stages 1 and 2
10C/10638	Resistance unit, type 131	1		
10C/16632	Resistance, type 404 ..	1	R_{10}	10,000 ohms
10C/10633	Resistance, type 405 ..	1	R_{11}	1,000 ohms
10D/11196	Exciter unit, type 1 ..	1	Ref. in fig. 2	Unit A
	Fitted with			
10C/10634	Resistance, type 406 ..	1	R_{12}	500 ohms
10C/10635	Resistance, type 407 ..	1	R_{13}	750 ohms
10C/10636	Resistance, type 408 ..	1	R_{15}	105 ohms
10C/10857	Resistance, type 438 ..	1	R_{14}	200 ohms
10F/10640	Switch, type 272 ..	2	S_5, S_6	Circuit breaker
10F/10728	Switch type, 273 ..	1	S_1	Thermostat

Ref. No.	Nomenclature	Qty.	Ref.	Remarks.
	Blind approach transmitter equipment (contd.)			
	Comprising			
10D/10620	Transmitter, type T.1122 (contd.)			Main beacon
	Consisting of			
10Q/11199	Indicating unit, type 47..	1		Unit J
10K/11202	Power unit, type 108 ..	1		Unit F
10D/11203	Rectifier, type X ..	1		Unit G
10D/11204	Rectifier, type Y ..	1		Unit H
10D/10750	Transmitter, type T.1123 ..	1		Inner marker beacon
	Consisting of			
10U/32	Amplifying unit, type 108	1		
10D/505	Modulator unit, type 26..	1		
10D/506	Modulator unit, type 27..	1		
10K/305	Power unit, type 109 ..	1		
10D/43	Transmitter, type T.1123A ..	1		Outer marker beacon
	Consisting of			
10U/34	Amplifying unit, type 109	1		
10D/505	Modulator unit, type 26..	1		
10D/546	Modulator unit, type 28..	1		
10K/305	Power unit, type 109 ..	1		
10U/11197	Amplifier unit, type 96	1	Ref. in fig. 2	Unit B
	Principal components			
	Condenser			
10C/9133	Type 260	2	C_1, C_8	0.001 μ F
10C/10650	Type 448	2	C_2, C_3	0.01 μ F
10C/10651	Type 449	1	C_7	0.1 μ F
	Choke, H.F.			
10C/2961	Type 169	1	L_1	247-LU-2A
10C/10653	Type 182	1	L_3	247-LU-3A
10A/3092	Milliammeter, type A ..	1	M_1	0-500 mA
	Resistance			
10C/10659	Type 411	1	R_1	50 ohms, tapped
10C/11319	Type 471	1	R_2	20 ohms
10C/1636	Type 1,636	2	R_3	15,000 ohms
	Accessories			
10E/10654	Valve, type 4304-BB ..	2	V_1, V_2	
10U/11198	Amplifier unit, type 97	1	Ref. in fig. 2	Unit C
	Principal components			
10A/10856	Ammeter, type E	1	M_2	0-1A
	Choke, H.F.			
10C/2961	Type 169	1	L_2	247-LU-3B
10C/10657	Type 170	1	L_1	247-LU-2B
	Condenser			
10C/9133	Type 260	2	C_1, C_2	0.001 μ F
10C/10650	Type 448	2	C_3, C_4	0.01 μ F
10C/10655	Type 450	1	C_9	0.001 μ F
10C/10656	Type 451	1	C_{10}	0.01 μ F
10A/10855	Milliammeter, type C ..	1	M_1	0-250 mA
	Resistance			
10C/10659	Type 411	1	R_1	50 Ω ohms, tapped
10C/207	Type 675	1	R_4	100 Ω ohms
10C/11789	Type 879	2	R_2, R_3	75 ohms
	Accessories			
10A/10660	Valve, type 4251-AX ..	2	V_1, V_2	

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
10U/31	Amplifier unit, type 107	1	Ref. in fig. 2	Unit A
	Principal components			
	Choke, H.F.			
10C/10626	Type 165	2	L ₆ , L ₇	247-LU-3D
10C/10627	Type 166	2	L ₈ , L ₉	247-LU-3E
	Condenser			
10C/10511	Type 378	2	C ₁₆ , C ₂₃	0.01 μ F
10C/10629	Type 440	3	C ₁₇ , C ₂₄ , C ₂₅	0.01 μ F, 1,000 volt
10C/10647	Type 445	3	C ₁₄ , C ₁₈ , C ₁₉	20 μ F, variable
10C/10648	Type 446	2	C ₁₅ , C ₂₀	40 μ F, variable
10C/10748	Type 458	1	C ₂₁	50 μ F
10C/10749	Type 459	1	C ₂₂	0.0001 μ F
	Milliammeter			
10A/3191	Type A	1	M ₄	0-200
10A/10834	Type H	1	M ₃	0-50
	Resistance			
10C/10841	Type 424	1	R ₉	10,000 ohms 1 W.
10C/10842	Type 425	1	R ₇	10,000 ohms 25 W.
10C/10845	Type 428	1	R ₈	50 ohms
	Transformer			
10K/10641	Type 161	1	T ₁	
10K/10642	Type 162	1	T ₂	
	Accessories			
10E/10643	Valve, type 4033A	4	V ₃ , V ₄ , V ₅ , V ₆	
	Amplifying unit			Unit R
10U/32	Type 108 or			For T.1123
10U/34	type 109			For T.1123A
	Principal components			
	Condenser			
10C/10511	Type 378	2	C ₄ , C ₉ , C ₂₅	101 μ F, for type 109 only
10C/10393	Type 403	2	C ₄ , C ₉ , C ₂₅	For type 108 only, 0.01 μ F
10C/10629	Type 440	1	C ₄₀	0.01 μ F
10C/10630	Type 441	1	C ₁₀	25 μ F
10C/10753	Type 462	2	C ₇ , C ₁₁	15 μ F, variable
10C/10754	Type 463	2	C ₁₂ , C ₂₁	22.5 μ F, variable
10C/10755	Type 464	1	C ₁₈	25 μ F
10C/10756	Type 465	2	C ₁₉ , C ₂₀	15 μ F, variable
10C/10757	Type 466	2	C ₂₂ , C ₃₈	9 μ F
10C/10758	Type 467	1	C ₃₃	60 μ F, variable
10C/10759	Type 468	1	C ₂₄	51 μ F
10C/11455	Type 527	1	C ₈	65 μ F, variable
10C/3439	Type 1,690	5	C ₁₃ , C ₁₅ , C ₁₆ , C ₁₇	0.01 μ F
	Choke, H.F.			
10C/10775	Type 176	1	C ₂₆	
10C/10776	Type 177	1	L ₅	
10C/10778	Type 178	1	L ₆	
10C/10779	Type 179	3	L ₈	
	Inductance			
10C/10771	Type 91	1	L ₇	
10C/10772	Type 92	1	L ₂	
10C/10773	Type 93	2	L ₃	
10C/10774	Type 94	1	L _{4a} , L _{4c}	
			L _{4b}	

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
	Amplifying unit, type 108 or type 109 (<i>cont'd.</i>)			
	Principal components (<i>cont'd.</i>)			
	Milliammeter			
10A/11279	Type E, 0-300	1	M ₂	
10A/11280	Type E, 0-500	1	M ₃	
10A/11278	Type G, 0-50	1	M ₁	
	Resistance			
10C/7957	Type 104	1	R ₁	10,000 ohms
10C/8670	Type 152	2	R ₇ , R ₁₃	500 ohms
10C/10842	Type 425	2	R ₃ , R ₈	10,000 ohms
10C/10846	Type 429	1	R ₁₁	100 ohms
10C/10850	Type 433	1	R ₉	2,000 ohms
10C/10851	Type 434	1	R ₁₀	250 ohms
10C/11321	Type 472	1	R ₅	5,000 ohms
10C/813	Type 919	1	R ₆	10,000 ohms
	Control unit, type 33			
	Principal components		Ref. in fig. 3	V/F control unit D
	Condenser			
10C/10749	Type 459	2	C ₁ , C ₂	0.0001 μ F
10C/10821	Type 480	1	C ₃	0.2 μ F
10C/10822	Type 481	1	C ₄	2 μ F
10C/10823	Type 482	1	C ₅	1 μ F
10C/10824	Type 483	1	C ₆	4 μ F
10C/10825	Type 484	1	C ₇	4 μ F
10C/10826	Type 485	2	C ₈ , C ₉	0.1 μ F
10C/10837	Milliammeter, 0-10, type R ..	1	M ₃	0-10 mA.
10K/10730	Motor, type 19	1	MOT ₁	
	Relay, magnetic			
10A/10661	Type 140	1	REL ₁	4605
10A/10662	Type 141	1	REL ₂	4601
10A/10663	Type 142	1	REL ₃	4617
	Resistance			
10C/10633	Type 405	1	R ₂	1,000 Ω
10C/10664	Type 412	1	R ₃	10,000 Ω
10C/10665	Type 413	1	R ₅	2,500 Ω
10C/10666	Type 414	1	R ₆	140 Ω
10C/10831	Type 468	1	R ₁	2,500 Ω
10C/10797	Type 469	1	R ₄	500 Ω
	Switch, key			
10F/10667	Type 264	2	S ₁ , S ₄	4635
10F/10668	Type 265	1	S ₂	4634
10F/10670	Type 269	1	S ₅	0.25 A
10F/10671	Type 270	1	S ₆	Santon
10F/10672	Type 271	2	S ₇ , S ₈	1.0 A
	Transformer			
10K/10673	Type 158	1	T ₁	4337-1
10K/10674	Type 159	1	T ₂	4337-3
10K/10675	Type 160	1	T ₃	RL7008-15-21
	Voltmeter, rectifier			
10A/10835	Type A, 0-400	1	M ₁	Includes R ₇
10A/10836	Type A, 0-5	1	M ₂	0-5 V
	Accessories			
5L/1538	Lamp, filament 12 V	4	PL ₁ , PL ₂ , PL ₃ , PL ₄	

Ref. No.	Nomenclature	Qty	Ref.	Remarks
10L/12021	Control unit, type 14			
	Principal components			
	Switch			
10F/85	Type 207	2		S.P. push button
10F/86	Type 208	1		D.P. push button
10L/11201	Control unit, type 34	1	Ref. in fig. 3	
	Principal components			D.C. control unit E
	Choke, L.F.			
10A/10676	Type 112	1	L ₁	RL7009-15-5
	Condenser			
10C/9805	Type 338	1	C ₁	4 μ F
10C/9807	Type 340	1	C ₂	10 μ F
10C/10824	Type 383	1	C ₃	4 μ F
	Relay, magnetic			
10F/10680	Type 138	1	REL ₁	4615 AP
10F/10681	Type 139	1	REL ₂	4615 AR
	Resistance			
10C/10682	Type 415	2	R ₁ , R ₂	2,000 ohms
10C/10683	Type 416	1	R ₃	2,000 ohms
10C/10684	Type 417	2	R ₄ , R ₅	1,000 ohms
	Switch			
10F/10667	Type 264	1	S ₁	4635
10F/10668	Type 265	1	S ₄	4634
10F/10669	Type 266	2	S ₃ , S ₅	4657
10F/10685	Type 267	1	S ₂	Lundberg 21160
10F/10686	Type 268	1	S ₆	Santon R. 148A
	Voltmeter			
10A/10677	Type A, 0-7.5 and 0-25 ..	1	M ₁	With R ₈ to R ₁₁
10A/10678	Type A, 0-250 and 0-350 ..	1	M ₂	With R ₁₂ , R ₁₃
10A/10679	Type A, 0-1,500 and 0-2,500	1	M ₃	With R ₁₄ , R ₁₅
	Accessories			
5L/2012	Lamp, filament, 12 V ..	1	PL ₁	
10L/10800	Control unit, type 35			Remote control unit P
	Principal components		Ref. in fig. 10	
	Condenser			
10C/10801	Type 477	3	C ₁ , C ₂ , C ₃	0.5 μ F
10C/10802	Type 478	1	C ₄	80 μ F
10C/10803	Type 479	11	C ₅ to C ₁₅	2 μ F
	Inductance			
10C/10804	Type 88	1	L ₁	4026A
10C/10805	Type 25	11	L ₂ to L ₁₂	4071 A
	Milliammeter.			
10A/10804	Type J (0-1)	1	M ₁	0-100 mA
10A/10840	Type E (0-100)	3	M ₂ to M ₄	0-100 mA
	Rectifier, metal			
10D/10705	Type 26	3	RECT ₁ to RECT ₃	B.18-1-1
10D/10812	Type 29	6	RECT ₄ to RECT ₉	B.18-3-1
	Relay, magnetic			
10F/10806	Type 147	3	REL ₁ to REL ₃	S.T.C.4603
10F/10807	Type 148	1	REL ₄	Siemens
10F/10808	Type 149	1	REL ₅	S.T.C.4615-AD
10F/10809	Type 150	1	REL ₆	S.T.C.4615-DB
10F/10810	Type 151	1	REL ₇	S.T.C.4604-AN
10F/10763	Type 152	6	REL ₈ to REL ₁₃	S.T.C.4602-AXY
10F/10811	Type 153	3	REL ₁₄ to REL ₁₆	S.T.C.4142-AE

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
	Control unit, type 35 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Resistance			
10C/10852	Type 435	3	R ₁ to R ₃	2,500 ohms
10C/10853	Type 436	1	R ₄	250 ohms
	Switch			
10F/10813	Type 282	1	S ₁	7-position
10F/10814	Type 283	2	S ₂	4-position
10F/10815	Type 284	3	S ₃ to S ₅	S.T.C.4658
10F/10816	Type 285	1	S ₆	S.T.C.4120
	Transformer			
10K/10673	Type 158	3	T ₁ to T ₃	A.M.4337-4
10K/10818	Type 170	1	T ₄	4086-H
	Accessories			
5A/1538	Lamp, filament, 12 V	6	PL ₁ to PL ₆	S.O.C.
5A/1638	Lamp, filament, 24 V	1	PL ₇	Jack type
10Q/11199	Indicating unit, type 47	1	Ref. in fig. 2	Unit J
	Principal components			
10A/10723	Ammeter, thermo type A, 0-5	1	M ₁	Turner
	Choke, H.F.			
10C/10724	Type 171	1	L ₁	
10C/10725	Type 172	2	L ₂ , L ₃	
10C/10726	Type 173	2	L ₄	Moving members
10C/10727	Type 174	1	L ₄	Fixed members
10C/9133	Condenser, type 260	1	C ₁	0.001 μ F
10C/9633	Resistance, type 271	1	R ₁	5,000 ohms
	Accessories			
10E/10643	Valve, type 4033A	1	V ₁	S.T.C.
	Modulator unit, type 25		Ref. in fig. 2	Crystal oscillator and R.F. modulator (Unit A)
	Principal components			
	Choke, H.F.			
10C/10622	Type 162	1	L ₂	
10C/10623	Type 163	1	L ₃	
10C/10625	Type 164	1	L ₅	
	Condenser			
10C/10511	Type 378	3	C ₅ , C ₆ , C ₁₂	0.01 μ F
10C/10629	Type 440	3	C ₇ , C ₁₁ , C ₁₃	0.01 μ F
10C/10630	Type 441	1	C ₉	25 μ F
10C/10644	Type 442	1	C ₂	0.0003 μ F
10C/10645	Type 443	1	C ₃	0.0002 μ F
10C/10646	Type 444	1	C ₄	0.0002 μ F
10C/10647	Type 445	2	C ₈ , C ₁₀	20 μ F
10C/2041	Type 446	1	C ₁	0.0002 μ F
	Inductance			
10C/10621	Type 72	1	L ₁	
10C/10624	Type 75	1	L ₄	
	Milliammeter			
10A/7177	Type A, 0-5	1	M ₁	
10A/1504	Type A, 0-100	1	M ₂	
	Resistance			
10C/8570	Type 152	1	R ₁₉	500 ohms
10C/10034	Type 342	1	R ₁	100 ohms
10C/10637	Type 409	1	R ₁₆	Cressal mat
10C/10841	Type 424	2	R ₂ , R ₅	10,000 ohms

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
	Modulator unit, type 25 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Resistance (<i>contd.</i>)			
10C/10842	Type 425	1	R ₃	10,000 ohms
10C/10843	Type 426	1	R ₄	15,000 ohms
10C/10844	Type 427	1	R ₅	10,000 ohms
10F/10729	Switch, type 274	1	S ₁	Thermostat
	Accessories			
	Crystal unit			
10X/34050	Type A	1	X ₁	
	or			
10X/37050	Type A	1	X ₁	
	or			
10X/38050	Type A	1	X ₁	
10E/10643	Valve, type 4033A	2	V ₁ , V ₂	
10D/505	Modulator unit, type 26	1	Ref. in fig. 9	A.F. Modulator unit (R)
	Principal components			
10C/10780	Choke, L.F., type 116	1	L ₁₁	
	Condenser			
10C/10755	Type 464	1	C ₃₁	25 μ F
10C/10760	Type 469	1	C ₂₇	0.172 μ F
10C/10761	Type 470	1	C ₂₉	0.04 μ F
10C/10764	Type 473	1	C ₃₄	4 μ F
10C/10765	Type 474	1	C ₃₅	2 μ F
10C/10766	Type 475	1	C ₃₆	6 μ F
10C/11320	Type 514	1	C ₃₉	0.07 μ F
10C/3439	Type 1,690	2	C ₂₈	0.01 μ F
10A/10798	Milliammeter, type E	1	M ₁	0-5 mA
10D/10799	Rectifier, metal, type 31	4	RECT ₂	
	Relay, magnetic			
10F/10680	Type 138	1	REL ₂	4615-AP
10F/10681	Type 139	1	REL ₁	4615-AR
10F/10639	Type 155	1	REL ₃	4663-MD
	Resistance			
10C/8570	Type 152	1	R ₁₃	500 ohms
10C/10682	Type 415	2	R ₁₈ , R ₁₉	2,000 ohms, variable
10C/10698	Type 420	1	R ₁₅	50,000 ohms
10C/10768	Type 421	1	R ₁₆	5,000 ohms, variable
10C/10852	Type 435	1	R ₁₂	2,500 ohms
10C/11805	Type 486	1	R ₂₀	7,500 ohms
10C/46	Type 558	1	R ₂₃	10 ohms
10C/143	Type 611	1	R ₁₄	25,000 ohms
	Switch			
10F/10781	Type 288	1	S ₁	
10F/10782	Type 289	1	S ₂	
10F/10783	Type 290	1	S ₃	
10F/60784	Type 291	1	S ₄	
10F/10716	Type 292	2	S ₅ , S ₆	
	Transformer			
10K/10673	Type 158	1	T ₃	
10K/10675	Type 160	1	T ₄	
10K/10785	Type 172	1	T ₁	

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
	Modulator unit, type 26 (<i>contd.</i>)			
	Accessories			
5A/2012	Lamp, filament	1	PL ₁	
10A/10631	Lamp, indicating	1	PL ₂	
10E/10643	Valve, type 4033A	1	V ₇	
	Modulator unit		Ref. in fig. 9	R.F. modulator, Unit R
10D/506	Type 27			T.1123 only
	or			
10D/546	Type 28			T.1123A only
	Principal components			
	Condenser			
10C/10511	Type 378	1	C ₄	T.1123A only ; 0.01 μ F
10C/10391	Type 401	1	C ₅	0.002 μ F
10C/10393	Type 403	1	C ₄	T.1123 only ; 0.01 μ F
10C/10752	Type 461	1	C ₂	0.0008 μ F
10C/10830	Type 489	1	C ₃	0.0005 μ F
10C/2896	Type 1,388	1	C ₁	0.00018 μ F, vari- able
10C/10770	Inductance, type 90	1	L ₁	
	Resistance			
10C/10847	Type 430	1	R ₂	20 ohms
10C/813	Type 919	1	R ₁	10,000 ohms
	Accessories			
10E/10643	Valve, type 4033A	1	V ₁	
10L/10880	Power unit, type 107		Ref. in fig. 10	Remote control supply, Unit S
	Principal components			
10C/10699	Choke, L.F., type 114	1	L ₁	
10C/10628	Choke, H.F., type 167	2	L ₂ , L ₃	
	Condenser			
10C/10833	Type 508	2	C ₁ , C ₂	0.1 μ F
10C/9382	Type 307		C ₃	2 μ F
10H/11790	Fuse, type 37	2	F ₁ , F ₂	
10D/10882	Rectifier, metal, type 43	2	RECT ₁	
10C/10854	Resistance, type 437	1	R ₁	120
10F/10685	Switch, type 267	1	S ₁	
10H/10581	Transformer, type 176	1	T ₁	
10K/11202	Power unit, type 108	1	Ref. in fig.	Unit F
	Principal components			
10A/10839	Ammeter, 0-20, type A	1	M ₂	
10K/10696	Fan, type 11	1	FAN ₁	
	Resistance			
10C/10688	Type 418	1	R ₁	20 ohms
10C/10689	Type 419	2	R ₂ , R ₃	0.46 ohm
	Switch			
10F/10692	Type 275	1	S ₃	Circuit breaker
10F/10690	Type 279	1	S ₁	S.T.C.
10F/10691	Type 280	2	S ₂ , S ₅	Santon
10F/10693	Type 281	1	S ₄	Circuit breaker
10K/10495	Transformer, type 169	1	T ₁	

Ref. No.	Nomenclature.	Qty.	Ref.	Remarks.
	Power unit, type 108 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Voltmeter			
10A/10687	Type A, 0-10 and 0-15	1	M ₃	With R ₄
10A/10838	Type A, 0-250	1	M ₁	With R ₅
10K/10793	Type 39	2	F ₂ , F ₃	1 amp.
10H/10794	Type 40	1	F ₄	1 amp.
10K/305	Power unit, type 109	1	Ref. in fig. 9	Marker beacon supply, Unit R
	Principal components			
10C/10699	Choke, L.F., type 114	1	L ₁₂	
10C/10832	Condenser, type 190	2	C ₃₂ , C ₃₃	10 μ F
10H/10789	Fuse, type 36	1	F ₁	
10D/10787	Rectifier, metal, type 30	4	RECT ₁	
10C/10769	Resistance, type 422	1	R ₁₇	12 ohms
10F/684	Switch, type 538	1		Contact units
	Fitted with			
10K/10788	Motor, type 35	1	MOT ₁	
10K/10786	Transformer, type 173	1	T ₂	Mains transformer
	Rectifier, type X		Ref. in fig. 6	
	Principal components			Unit G
	Choke, L.F.			
10C/10676	Type 112	1	L ₂	
10C/10697	Type 113	1	L ₁	
10C/10699	Type 114	1	L ₃	
10C/10700	Type 115	1	L ₅	
	Condenser			
10C/9807	Type 340	9	C ₁ to C ₉	10 μ F, 400 V
10C/10827	Type 486	2	C ₉ , C ₁₀	10 μ F, 500 V
10K/10715	Fan, type 10	1	FAN ₁	
	Fuse			
10H/10792	Type 38	1	F ₁	15 amp.
10H/10793	Type 39	2	F ₂ , F ₃	1 amp.
10H/10794	Type 40	1	F ₄	1 amp.
	Rectifier			
10D/10701	Type 22	1	RECT ₁	7012-15-6
10D/10702	Type 23	1	RECT ₂	7012-15-5
10D/10703	Type 24	1	RECT ₃	7012-15-4
10D/10704	Type 25	1	RECT ₄	7012-15-3
10D/10705	Type 26	1	RECT ₅	B18-1-1
	Relay, magnetic			
10F/10705	Type 143	1	REL ₁	4601 A.F.P.
10F/10707	Type 144	1	REL ₂	7013-15-9
10F/10708	Type 145	1	REL ₃	4622-EA
10F/10709	Type 146	1	REL ₄	4601-AWE
	Switch			
10A/10692	Type 275	2	S ₁ , S ₂	RL7013-15-4
10A/10710	Type 276	3	S ₃ , S ₄ , S ₅	RL7013-15-6
	Transformer			
10K/10711	Type 163	1	T ₁	7008-15-19
10K/10712	Type 164	1	T ₂	7008-15-17
10K/10713	Type 165	1	T ₃	7008-15-18
10K/10714	Type 166	1	T ₄	7008-15-16

Ref. No.	Nomenclature	Qty.	Ref.	Remarks
	Rectifier unit, type Y			
	Principal components			
10C/10699	Choke, L.F., type 114 ..	3	L ₁ , L ₂ , L ₃	
	Condenser			
10C/10828	Type 509	2	C ₁ , C ₂	4 μ F
10C/10829	Type 510	2	C ₃ , C ₄	4 μ F
	Fuse, cartridge			
10H/10795	Type 41	1	F ₁	1 amp.
10H/10796	Type 42	1	F ₂	2 amp.
	Rectifier, metal			
10D/10717	Type 27	18	RECT ₁	7012-15-2
10D/10718	Type 28	24	RECT ₂	7012-15-1
	Switch			
10F/10719	Type 277	1	S ₁	7013-15-7
10F/10720	Type 278	1	S ₂	7013-15-6
	Transformer			
10K/10721	Type 167	1	T ₁	7008-15-15
10K/10722	Type 168	1	T ₂	7008-15-14
	Relay unit, type 7 and type 8 ..		Ref. in fig. 3	Units K and L
	Principal components			
10C/11117	Choke, H.F., type 175 ..	2	L ₁ , L ₂	
10F/10732	Relay, type 252	1	REL ₁	Unit L only
	or			
10F/10731	Relay, type 251	1	REL ₁	Unit K only
10C/10638	Resistance unit, type 131 ..		Ref. in fig. 2	Oven heater unit A
	Principal components		R ₁₇ , R ₁₈	
10C/6097	Type 6097	1		15 ohms
10C/6098	Type 6098	1		40 ohms
10C/6099	Type 6099	1		35 ohms
10C/6100	Type 6100	1		25 ohms
10C/6101	Type 6101	1		6 ohms

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SECTION 1, CHAPTER 12

TRANSMITTER T.1190

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**CONCISE DETAILS OF
TRANSMITTER T.1190**

PURPOSE OF EQUIPMENT	Ground station transmitter		
TYPE OF WAVE	C.W., M.C.W. and R/T		
FREQUENCY RANGE	1.5 Mc/s to 15 Mc/s		
FREQUENCY STABILITY	Crystal control or master oscillator		
CRYSTAL MULT. FACTOR	1.5 Mc/s to 3 Mc/s. Crystal fundamental 3 Mc/s to 7.5 Mc/s. Crystal fundamental or X2 7.5 Mc/s to 15 Mc/s. X2		
PERCENTAGE MODULATION	80 per cent.		
MAXIMUM SENSITIVITY	Not applicable		
SELECTIVITY	Not applicable		
OUTPUT IMPEDANCE	Balanced 600 ohm lines or low impedance coaxial feeder		
AMPLIFIER CLASS	Class B, parallel power amplifier stage		
MICROPHONE TYPE	Input from amplifier A.1104 using carbon granule microphone		
VALVES	2—V.T.96 Crystal oscillator and frequency doubler (Stores Ref. 10E/147) 2—V.T.31 Parallel R/F power amplifiers (Stores Ref. 10E/8739) 2—V.U.29 H.T. rectifiers (Stores Ref. 10E/8087) 1—V.U.39 Full wave valve rectifier for grid bias voltage (Stores Ref. 10E/9600)		
POWER INPUT	230 volts, 50 cycles		
POWER OUTPUT	350 watts on C.W. 80 watts on R/T.		
STORES REF. No.	10D/320		
APPROXIMATE OVERALL DIMENSIONS	DEPTH 1 ft. 10 in.	WIDTH 2 ft. 6 in.	HEIGHT 5 ft. 10 in.
WEIGHT	4½ cwt.		
ASSOCIATED EQUIPMENT	Remote controls, type 3		

TRANSMITTER T.1190

(STORES REF. 10D/320)

INTRODUCTION

1. The transmitter T.1190 is a ground station instrument for the transmission of C.W., M.C.W., and R/T over the frequency band from 1.5 Mc/s to 15 Mc/s. The frequency is stabilised by the use of quartz crystals operating on their normal frequency of from 1.5 Mc/s to 7.5 Mc/s.

2. The transmitter circuit comprises a crystal-controlled oscillator followed by a frequency-doubler driving an amplifier stage consisting of two valves in parallel. Provision is made for emission of a carrier frequency equal to the fundamental frequency of the crystal by removal of the frequency doubler valve and by slight circuit modification. To permit of operation on a frequency for which a crystal is not available the circuit may easily be changed to master-oscillator working.

3. The oscillator and frequency-doubler pentode valves, with their associated components, are contained in an adaptor, type 15, which has been designed for convenient insertion in, or removal from, the main body of the transmitter. Two tetrode valves, in parallel, are used in the amplifier section. A full-wave rectifier valve provides for the biasing voltages to the amplifier stage.

4. The transmitter may be worked into either coaxial cable or balanced 600-ohm lines (from 3 Mc/s to 15 Mc/s). Modulation is brought about by the use of an external amplifier, A.1104, which forms part of the remote control, type 3, or a modified form thereof, the keying being rendered inoperative by a switch in the remote control. For W/T operation the transmitter is keyed in the H.T. negative line.

5. The power for the T.1190 is normally obtained from a 230-volt, 50-cycle, A.C. supply and is used with a rectifying panel, type 11. The general appearance of the transmitter is shown in fig. 1. The dimensions are 5 ft. 10 in. high, 2 ft. 6 in. wide and 1 ft. 10 in. deep. The weight of the complete equipment is approximately $4\frac{1}{2}$ cwt.

GENERAL DESCRIPTION

6. The theoretical circuit diagram of the T.1190, omitting the rectifying apparatus, is given in fig. 2. The circuits of the rectifying panel, type 11, amplifier A.1104 and remote control equipment can be found elsewhere in this publication. The circuit of the adaptor, type 15, is shown contained within dotted lines on the diagram, fig. 2. The alternative output circuit connexion designed for the matching into low impedance lines and standard aerial systems is also indicated in fig. 2.

7. The circuit of the adaptor, type 15, consists of two directly-heated pentode valves arranged as a crystal-oscillator V_1 and a frequency-doubler V_2 . A crystal X_1 is connected between the grid and filament of the valve V_1 and across a grid-leak resistance R_1 . A resistance R_3 included between the top end of R_1 and the control grid, serves as a suppressor of parasitic oscillations and limits the amplitude of the physical vibration of X_1 to a safe working condition.

8. When necessary, particularly within the range below 3 Mc/s, feed-back to the crystal X_1 , is brought about by the internal anode to control-grid capacitance of the valve V_1 . The inter-electrode capacitance of the valve used, is in the neighbourhood of $0.03 \mu\mu\text{F}$. and a small amount of parallel capacitance is necessary to maintain oscillation. This is afforded by a special condenser C_3 one plate of which is exterior to the valve envelope, the other plate consisting of the valve anode. The exterior plate of C_3 consists of metal rod which is plugged into a socket Sk_7 . The device is interesting having regard to its approximation to a very small aerial system in the oscillatory field. When C_3 is not required the rod is inserted into a stowage socket Sk_{7a} .

9. The screen-grid voltage for V_1 is dropped to a suitable value by a resistance R_2 . To provide for adequate by-passing of the screen-grid, a condenser C_1 is included. A condenser C_2 is incorporated to provide a short return path for the crystal circuit.

10. The suppressor grid of V_1 is returned to the junction of two resistances R_5 and R_6 , constituting, with two condensers C_4 and C_5 , a filament centre-pointing device. The common filament leads to V_1 and V_2 include two R/F chokes L_2 and L_3 , the voltage being derived from the supply unit via a controlling rheostat R_8 . A voltmeter M_1 can be included in the filament circuits of either V_1 and V_2 or of the amplifying valve V_3 and V_4 by means of a double-pole, double-throw switch S_1 .

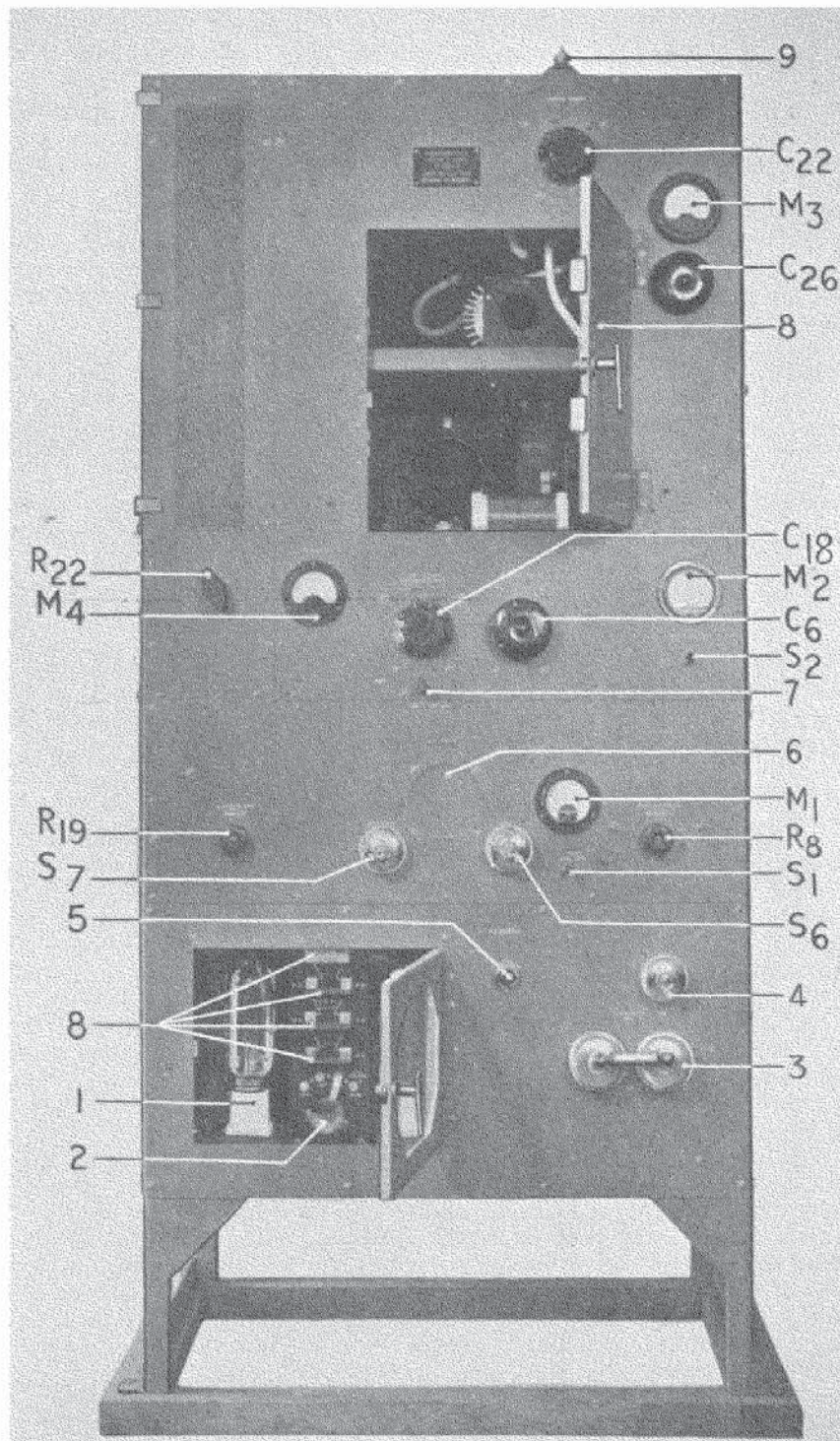


Fig. 1.—Transmitter T.1190

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35
R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35
L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20	L21	L22	L23	L24	L25	L26	L27	L28	L29	L30	L31	L32	L33	L34	L35
M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35
SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13	SK14	SK15	SK16	SK17	SK18	SK19	SK20	SK21	SK22	SK23	SK24	SK25	SK26	SK27	SK28	SK29	SK30	SK31	SK32	SK33	SK34	SK35
REL1	REL2	REL3	REL4	REL5	REL6	REL7	REL8	REL9	REL10	REL11	REL12	REL13	REL14	REL15	REL16	REL17	REL18	REL19	REL20	REL21	REL22	REL23	REL24	REL25	REL26	REL27	REL28	REL29	REL30	REL31	REL32	REL33	REL34	REL35

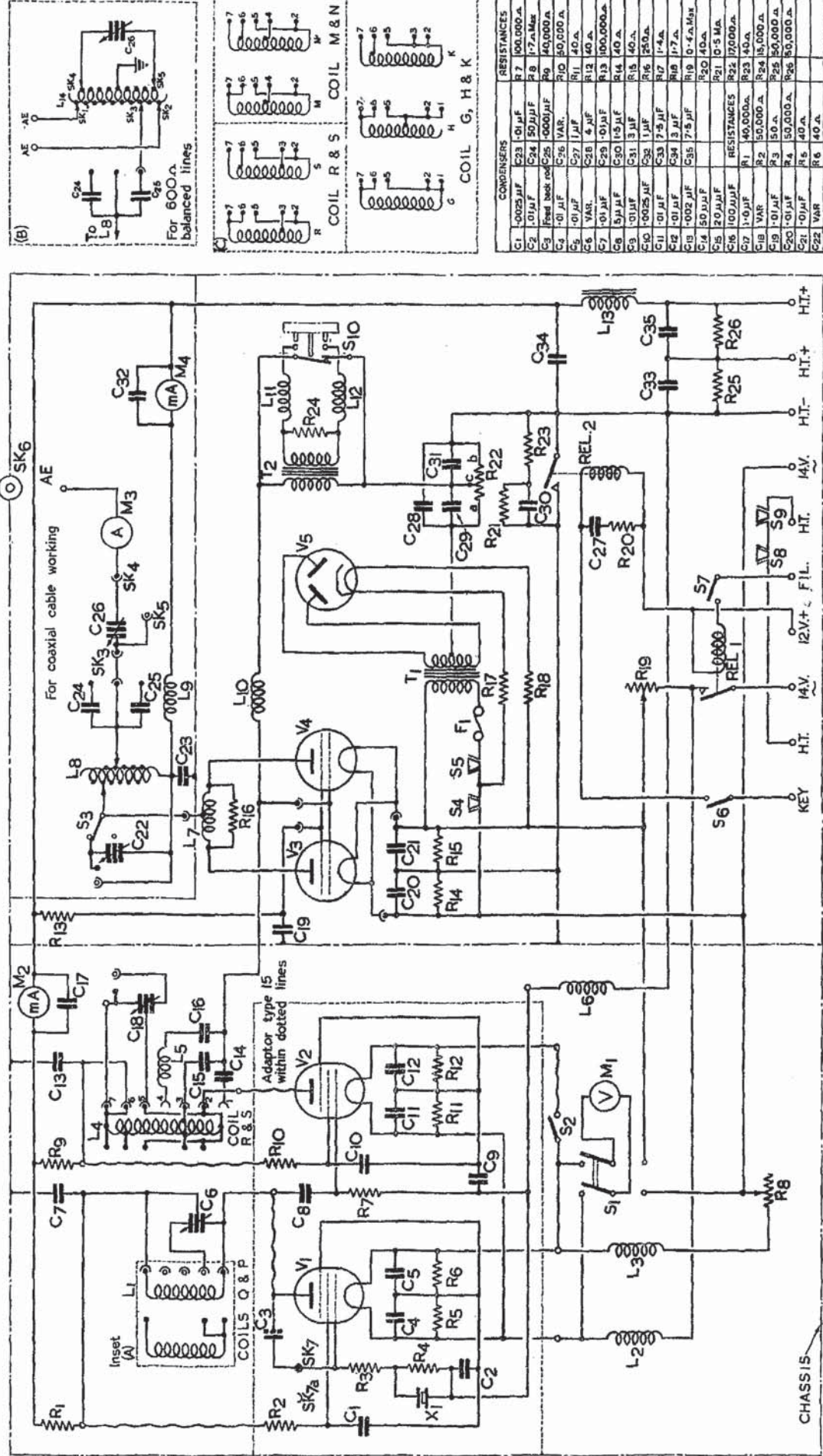


FIG. 2

T1190. CIRCUIT DIAGRAM

FIG. 2

11. The tuned anode circuit of V_1 includes an inductance L_1 in association with a variable condenser C_6 . The inductance L_1 may be, in practice, one of the plug-in coils P or Q for crystal oscillator, working when frequency doubling is used. These coils are so arranged that their plugs automatically select either one-half or the whole of the capacitance of C_6 . For crystal-oscillator working on fundamental, L_1 is the coil R. The coils P and Q with their base connexions are shown theoretically in the inset A of fig. 2.

12. The anode voltage of the valve V_1 is supplied through a dropping resistance R_1 and a condenser C_7 by-passes the anode line. The fundamental frequency oscillation from the anode of V_1 is coupled to the control grid of a pentode V_2 through a condenser C_8 . The filament centre-pointing, voltage-reducing and by-passing arrangements of this stage are similar to those of V_1 . A switch S_2 is included in the filament lead in order that V_2 may be switched off during the tuning of the anode circuit of the crystal-oscillator.

13. The tuned-anode circuit of V_2 is an inductance L_4 with a variable condenser C_{18} and is tuned to the second harmonic of the crystal X_1 . The inductance L_4 is a plug-in coil which may be any one of the coils, according to the range requirements and method of operation, as specified in the operational notes of this chapter. For the purpose of frequency-doubling, that is on the band from 3.0 Mc/s to 15 Mc/s the condenser C_{18} is used at half capacitance; for 1.5 Mc/s to 3.0 Mc/s, both sets of fixed vanes are paralleled by means of plug and socket connexions forming part of the coil assembly. According to the coil used, condensers C_{14} , C_{15} or a choke L_5 , with condenser C_{16} , are included in the line to the amplifier control grid. A resistance R_9 drops the anode voltage, the line being by-passed by a condenser C_{13} .

14. The H.T. supply to the anode of V_1 and V_2 is derived from the rectifier unit through a condenser-input filter network comprising the series capacitance of C_{35} and C_{33} bridging the system, a L/F choke coil L_{13} and a condenser C_{34} . Equal resistances, R_{26} and R_{25} , are in series across the input, their junction point being joined to the H.T. Mid. terminal of the rectifier and to the junction of C_{35} and C_{33} . A milliammeter M_2 shunted by a condenser C_{17} is included in the positive line.

15. The unbalanced output from the frequency-doubler V_2 is coupled (see para. 13) to an amplifier stage consisting of two directly heated tetrode valves V_3 and V_4 in parallel. The amplifier valves are housed in a special holder which is removable. The connexions from the holder and the main circuit are indicated on fig. 2. The H.T. positive supply for V_3 and V_4 is derived from the rectifier through the choke L_{13} , a milliammeter M_4 , shunted by a condenser C_{32} , a R/F choke L_9 , an anode coil L_8 , and the centre-point of a R/F suppressor choke L_7 , joining the anodes of the two amplifier valves V_3 and V_4 . A resistance R_{16} is across the choke L_7 . The coil L_8 is tuned by a variable condenser C_{22} which is similarly arranged with plug and socket as is C_{18} . A switch S_3 is also incorporated in C_{22} , the flexible lead and switch S_3 enabling C_{22} to be changed from series gap to parallel connexion.

16. The filament circuit of V_3 and V_4 is balanced to earth by a centre-pointing arrangement comprising condensers C_{20} and C_{21} , with resistances R_{14} and R_{15} . The filaments are heated from the 14-volt terminals of the power supply, the voltage being controlled by a rheostat R_{19} . The voltmeter M_1 and switch S_1 , referred to in para. 10, are included in the circuit. The screen-grid voltage for V_3 and V_4 is derived from the H.T. positive through L_{13} and a resistance R_{13} , the screen grids being by-passed by a condenser C_{19} .

17. The connexions used when working into either a direct aerial system or concentric feeder are shown in the main diagram, fig. 2. The amplifier closed circuit is directly coupled through a socket Sk_2 and plug P_3 to a variable condenser C_{24} and through a thermo-ammeter M_3 to a terminal for direct aerial or to a concentric output socket Sk_3 for coaxial feeding.

18. A balanced output circuit consisting of an inductance L_{14} , tuned by the variable condenser C_{26} , is available when working into a 600-ohm open line system. This is shown in inset B of fig. 2. Coupling from L_6 to L_{14} is made through a fixed condenser which may be either C_{24} or C_{25} . The aerial connexions to the output side of L_{14} are made by sockets Sk_1 , Sk_2 and plugs which form part of the coil L_{14} and are lettered from the centre or earthed point of the coil according to the amount of inductance incorporated.

Grid bias arrangements

19. Grid bias for the valves V_1 and V_2 in the adaptor circuit is obtained by means of grid-leak resistances R_4 and R_7 , these being returned to H.T. negative via a R/F choke coil L_6 . For the amplifier valves, however, grid bias is derived from a full-wave rectifier valve V_5 . A simplified diagram of the arrangement is shown in fig. 3. The primary winding of a transformer T_1 is connected across the filament supply for V_3 and V_4 which is derived from the A.C. mains. The rectified output is taken from the centre point of the secondary of T_1 and is applied to the grids of V_3 and V_4 via a potentiometer R_{23} and a R/F choke L_{10} . When the transmitter is modulated for R/T the secondary winding of a modulation transformer T_2 is included in the grid line.

20. It will be appreciated from the diagram, fig. 3 that the "hot" (unearthed) end (a) of the bias voltage resistance R_{22} is at negative potential with respect to the end (b). The wiping contact (c) of R_{22} therefore applies a greater or lesser degree of bias to the grids of V_3 and V_4 . A reservoir condenser C_{28} is across the resistance R_{22} and two voice-frequency by-pass condensers, C_{29} and C_{31} , are on either side of the tap.

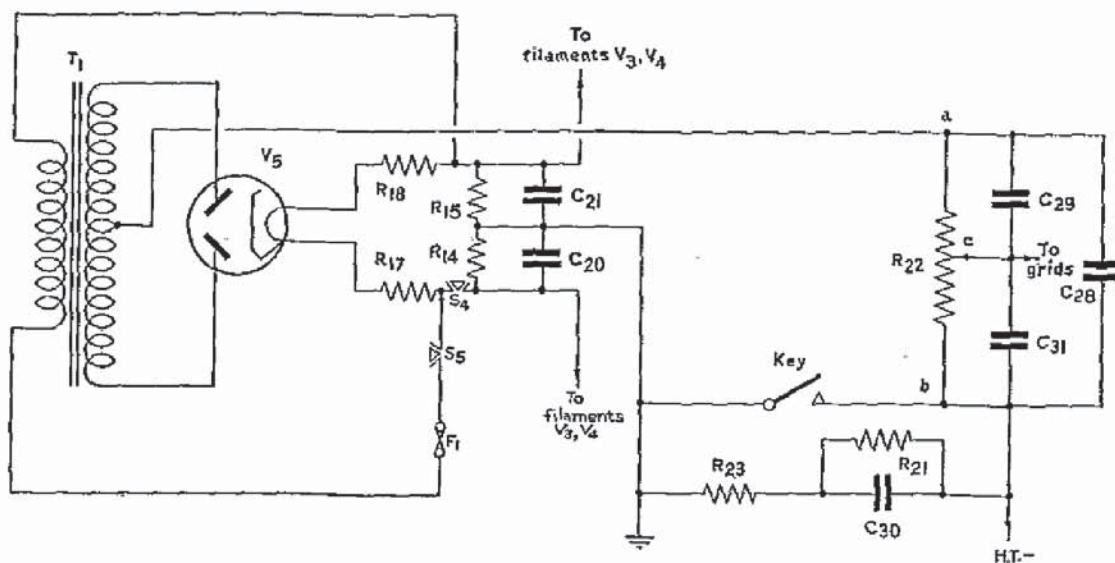


Fig. 3.—Simplified diagram of grid bias arrangements

21. The filament leads to V_5 incorporate resistances R_{17} and R_{18} , the latter being connected to the primary of the transformer T_1 . The resistance R_{19} is connected to the junction point of two gate switches S_4 and S_5 , which are included, with a fuse F_1 , in the transformer primary lead to the 14-volt supply. The filaments of the biasing valve V_5 are ON during the whole time the amplifier filaments are ON. A switch S_7 , included in the filament circuit brings a relay REL_1 into operation, REL_1 making the 14-volt circuit to all valves. Removal of the valve holder for V_3 and V_4 breaks the filament circuit to V_5 and the supply to the primary of T_1 by means of the gate switch S_4 . Opening the door at the front of the transmitter open-circuits the gate switch S_5 which removes the supply to the primary of the bias transformer T_1 but the heater circuit of the bias valve V_5 is still "made".

Keying

22. The keying circuit which includes a switch S_6 is operated from the 12-volt D.C. supply from the rectifier unit. When the key is at "mark" this voltage is made and actuates a relay REL_2 , the contacts of which connect the point "b" of R_{22} to the filament centre-point of the valves V_3 and V_4 and to earth. At "mark" therefore the H.T. negative line is made and the carrier signal frequency emitted. A filter circuit consisting of a resistance R_{23} , a condenser C_{30} , and a resistance R_{21} , prevents a too-rapid change between output and non-output condition to the aerial system. When the key is at "space" the H.T. negative lead is open circuited and all valves are biased negatively.

Modulation

23. When the modulating amplifier A.1104 is connected through a switch socket S_{10} the secondary winding of the modulation transformer T_2 is brought into circuit between the R/F choke L_{10} and bias resistance R_{22} . The primary winding of T_2 is shunted by a resistance R_{24} and the input lines incorporate R/F chokes L_{11} and L_{12} . When the instrument is being modulated for R/T the morse key is short-circuited by a switch in the remote control equipment.

24. In this condition the A/F voltages are superimposed upon the R/F carrier frequency through the grid circuit, thus varying the output power of the amplifier stage. The grid bias for R/T working is normally increased until the output current is 50 per cent. of that obtained in the zero bias condition. At 100 per cent modulation this output current rises approximately 20 per cent.

Fundamental frequency circuit

25. The necessary rearrangement of circuit to provide for transmission on the fundamental frequency of X_1 , and not on the second harmonic, is shown in fig. 4. In these circumstances the

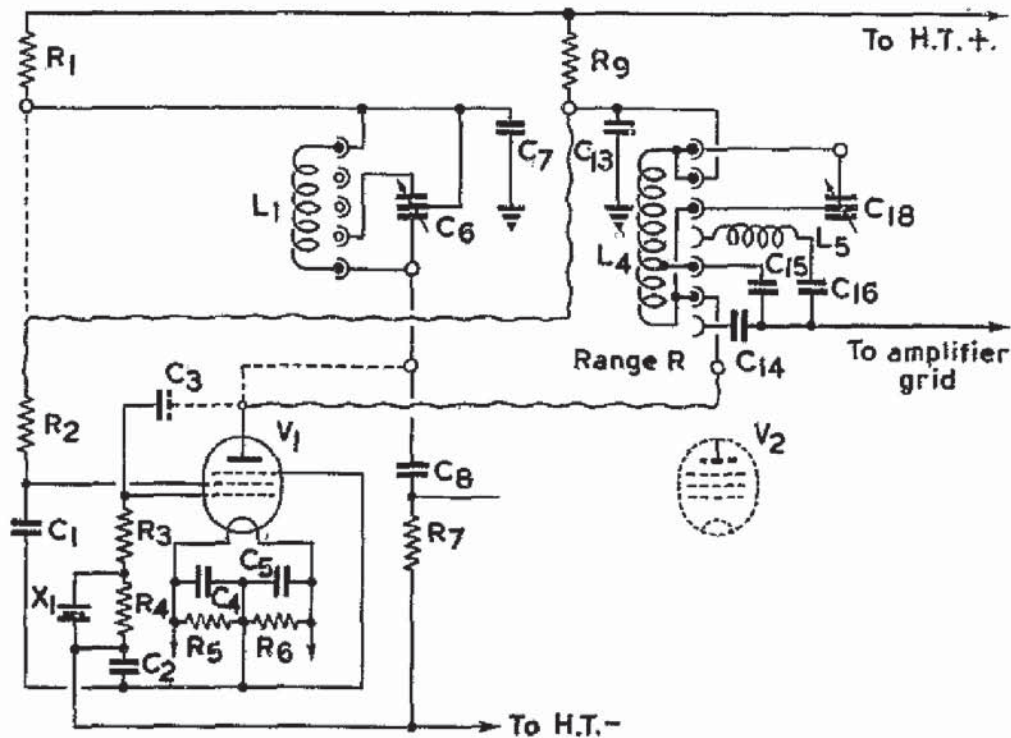


FIG. 4

CIRCUIT RE-ARRANGEMENT FOR CRYSTAL FUNDAMENTAL OPERATION

FIG. 4.

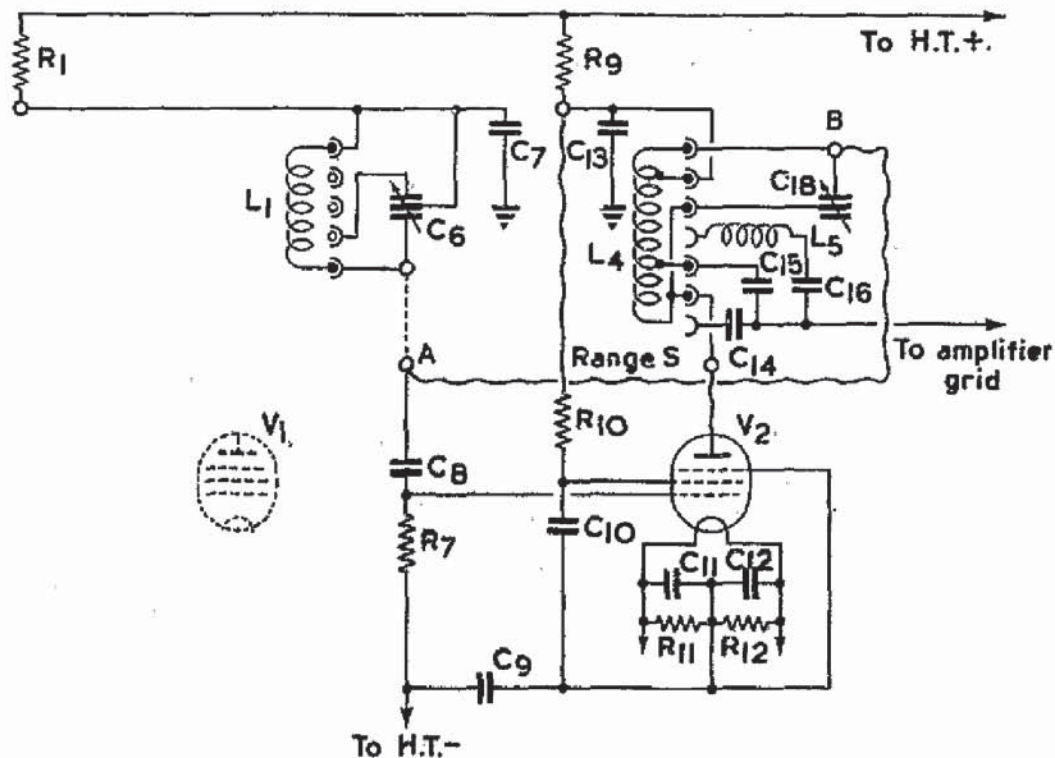


FIG. 5.

CIRCUIT RE-ARRANGEMENT FOR MASTER OSCILLATOR OPERATION

FIG. 5

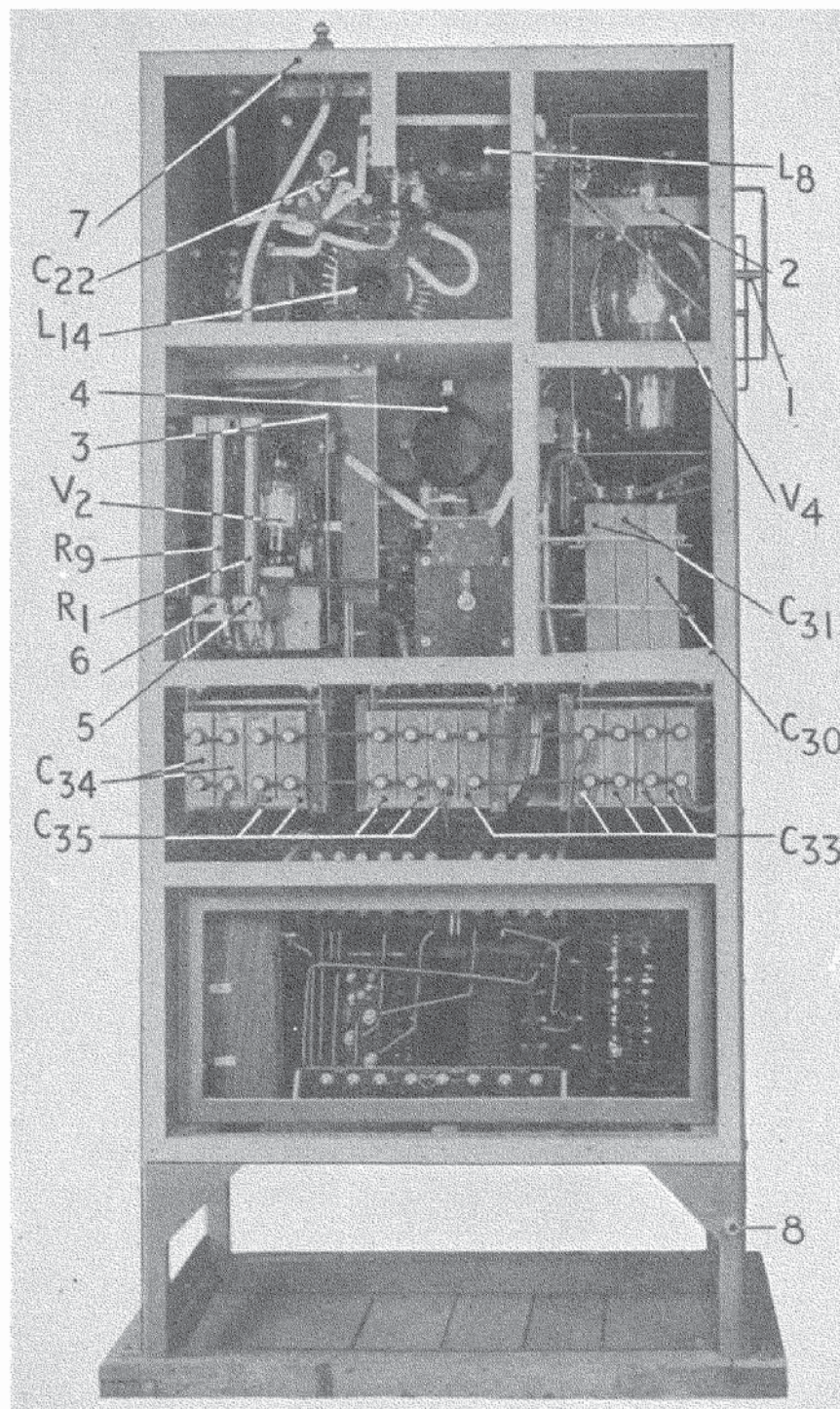


Fig. 6.—Rear view of transmitter with panels removed

valve V_2 is out of circuit and the connexions are arranged so that the oscillator drives directly into the valves V_3 and V_4 .

Master-oscillator circuit

26. The rearrangement of the circuit to provide for M/O operation over the range from 1.5 Mc/s to 15 Mc/s is shown in fig. 5. The frequency doubler valve V_2 is now used as the master oscillator and V_1 is removed from the circuit. In this case the H.T. is fed to a tap on the coil L_3 and the end (B) of the condenser C_{18} which is not connected to the anode is fed back from the point annotated (A) through the coupling condenser C_8 to the grid of V_2 forming a conventional Hartley oscillator circuit.

Coils

27. The theoretical circuit connexions of the various coils are shown in inset A in fig. 2. Five coils are used in the transmitter. For normal (frequency-doubling) operation L_1 may be either coil Q (3.0 Mc/s to 7.0 Mc/s) or coil P (7.0 Mc/s to 15.0 Mc/s); the inductance of L_1 may then be represented by the coil M and N (3.0 Mc/s–6.5 Mc/s) or sections G–H of the coil G, H and K (G, 6.5 Mc/s to 13.0 Mc/s; H, 13.0 Mc/s to 15.0 Mc/s).

28. For crystal fundamental operation the inductance of L_1 may be the coil R (1.5 Mc/s to 3.0 Mc/s), coil M (3.0 Mc/s to 6.5 Mc/s), or sections G of coil G, H and K (6.5 Mc/s to 15.0 Mc/s). For M/O operation the inductance of L_1 may be the coil S (1.5 Mc/s to 3.0 Mc/s), coil N (3.0 Mc/s to 6.5 Mc/s) or the K portion (7.0 Mc/s to 15.0 Mc/s) of the coil G, H and K.

29. Coil M and N, coil G, H and K, coil R, and coil S, are so designed that they connect the appropriate coupling condensers, C_{14} , C_{15} or C_{16} for each band. In the case of M and N an anti-parasitic choke L_5 is included in the circuit.

CONSTRUCTIONAL DETAILS

30. Several views of the transmitter are given in figs. 1, 6, 7, 8 and 9, and bench wiring diagrams in figs. 10 and 11. Views of the adaptor, type 15 and the valve holder, type O, are given in figs. 12, 13 and 15. The transmitter is built up in a metal framework with perforated panels. So far as is practicable the annotations of the illustrations have been made in accordance with those of fig. 2.

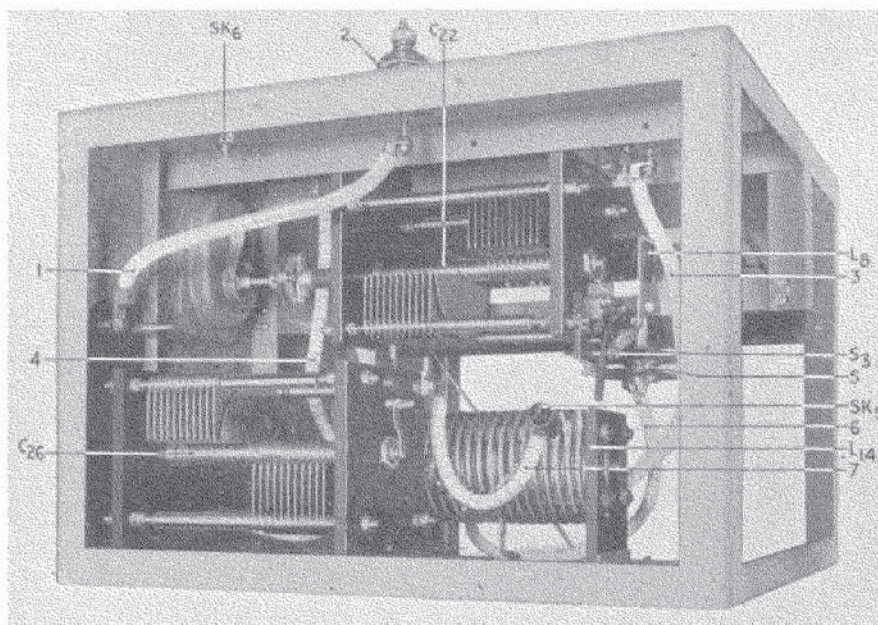


Fig. 7—Top section from right-hand side

The transmitter

31. The transmitter is built up in four sections the lowermost of which houses the rectifier components. The rectifier is similar to that of the T.1087 which is described in Section 1, Chapter 3, of this publication.

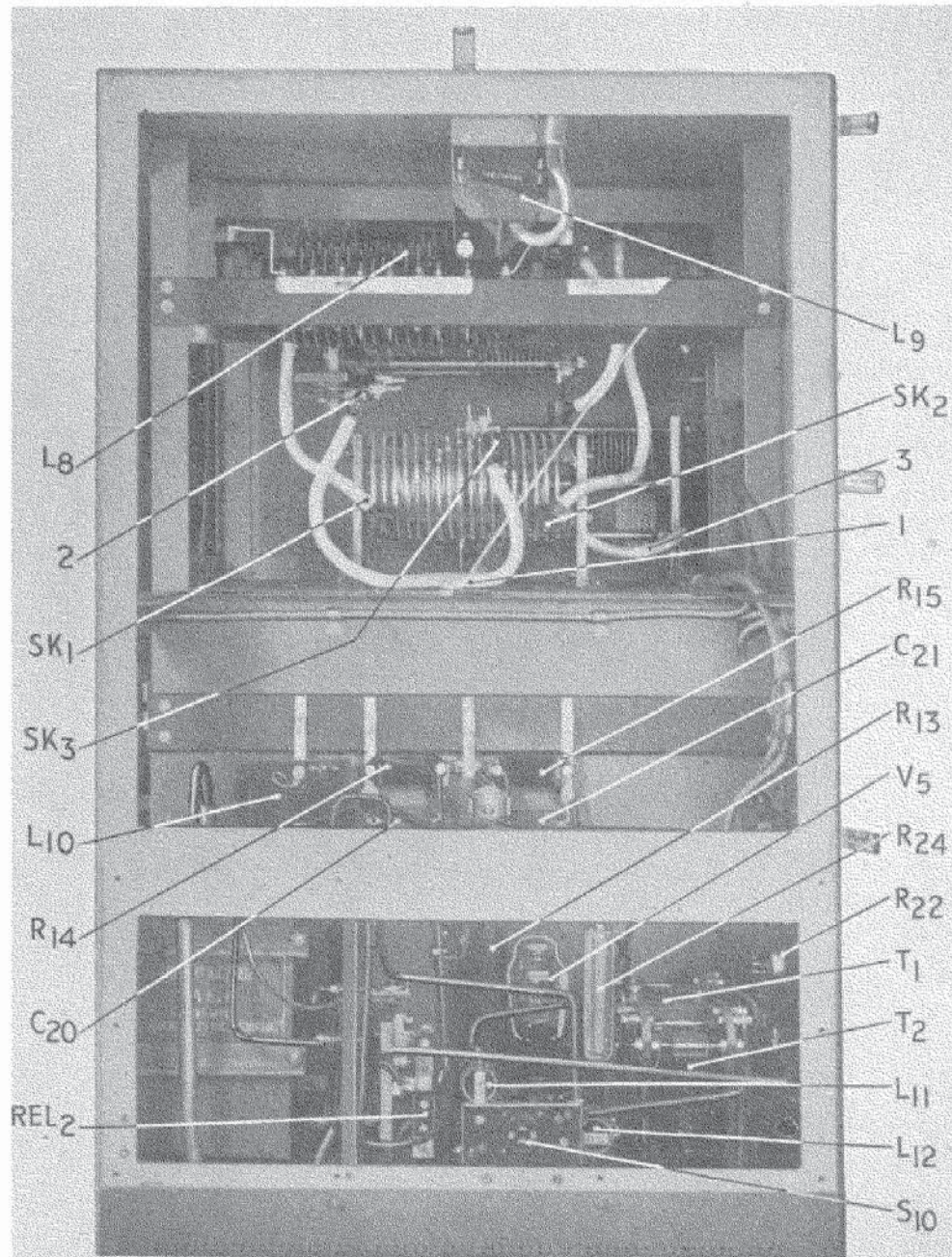


Fig 8.- Top and control sections from left-hand side

32. Referring to fig. 1, one of the rectifier valves (1) can be seen through the door at the left-hand bottom corner. The H.T. voltage control (2) with four positions engraved from 1 (1,600 v) to 4 (3,400 v) full voltage, can also be seen. The filaments main switch (3) and H.T. ON-OFF switch (4) are on the right of the rectifier panel. The pilot lamp viewing bezel (5) is towards the centre.

33. The smoothing unit panel carries the controlling rheostats, key and filament switches and the filament voltmeter with its double-throw switch, S_1 . Provision has been made (6) for the fitment of an H.T. voltmeter. The remaining front panel equipment is self-explanatory except for the fine tuning control (7) to the second stage tuning condenser C_{18} . It should be noted, however, that in certain versions of the transmitter the grid bias control R_{22} scale markings may differ from the original 0 to 8 marking.

34. A rear view of the T.1190 with panels removed is shown in fig. 6. The handles (1) by means of which the amplifier valve holder (2) type O, is removed from the instrument, are shown. The adaptor, type 15, can be seen on the left-hand side. The coil M, N (4) is in position. The transmitter output circuit, as seen in this illustration, is arranged for direct aerial operation.

35. A view of the top section from the right-hand side is given in fig. 7. The type 449 connector (1) joins the thermo-ammeter M_3 to an output insulator (2). The meter M_3 is not actually in circuit in the illustration, the transmitter being arranged for working into 600-ohm balanced lines. The socket Sk_1 is connected to the output coil end of the 405 connector (3). The socket Sk_2 is attached to a similar connector (4). The coupling unit type 14 (5) is below L_3 and a type 405 connector (6) terminates in a socket Sk_3 . A type 4 connector (7) is fitted with a socket Sk_5 . It should be noted that these sockets are engraved with a number corresponding to the annotational subscript used in this description, that is, socket "5" is Sk_5 .

36. A view of the top and control sections from the left-hand side is given in fig. 8. The valve holder has been removed. The sockets Sk_1 and Sk_2 lead, *via* connectors, to the output insulators. The socket Sk_3 taps the coil L_{11} *via* a type 404 connector (1) and goes to the coupling unit (2). In the control section view from the right-hand side, fig. 9, the coil (1) is the coil M. The ceramic former

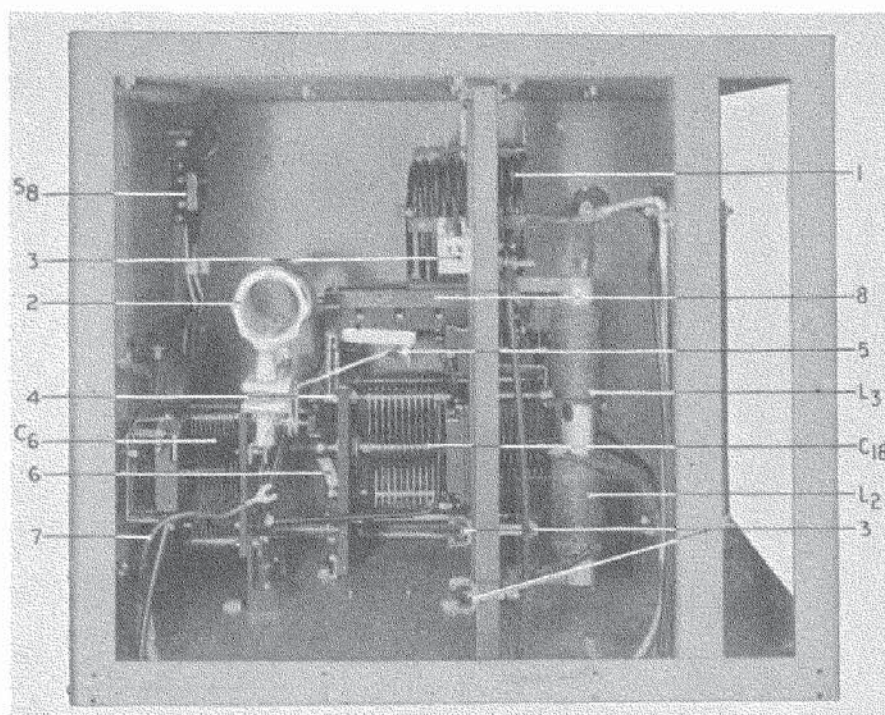
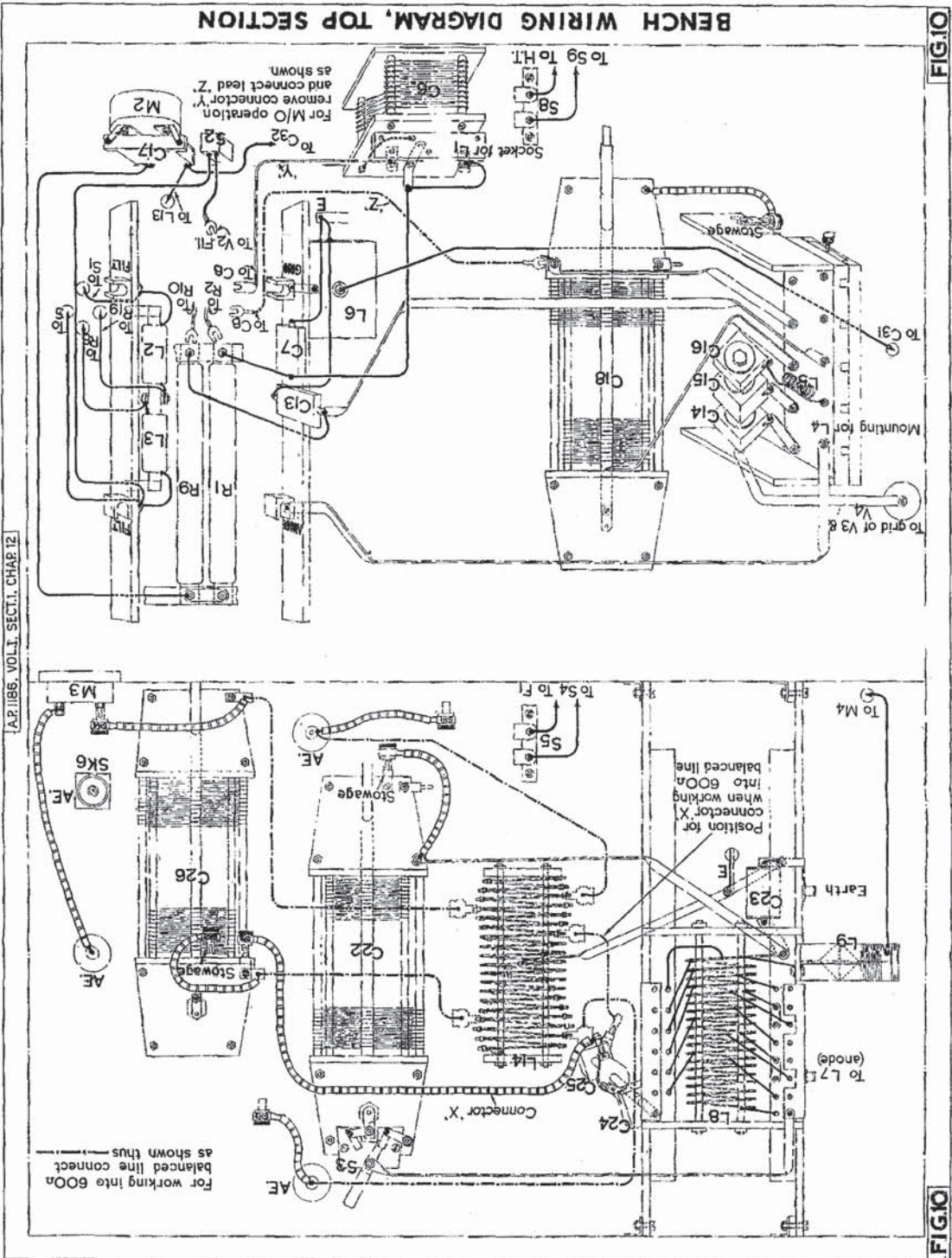
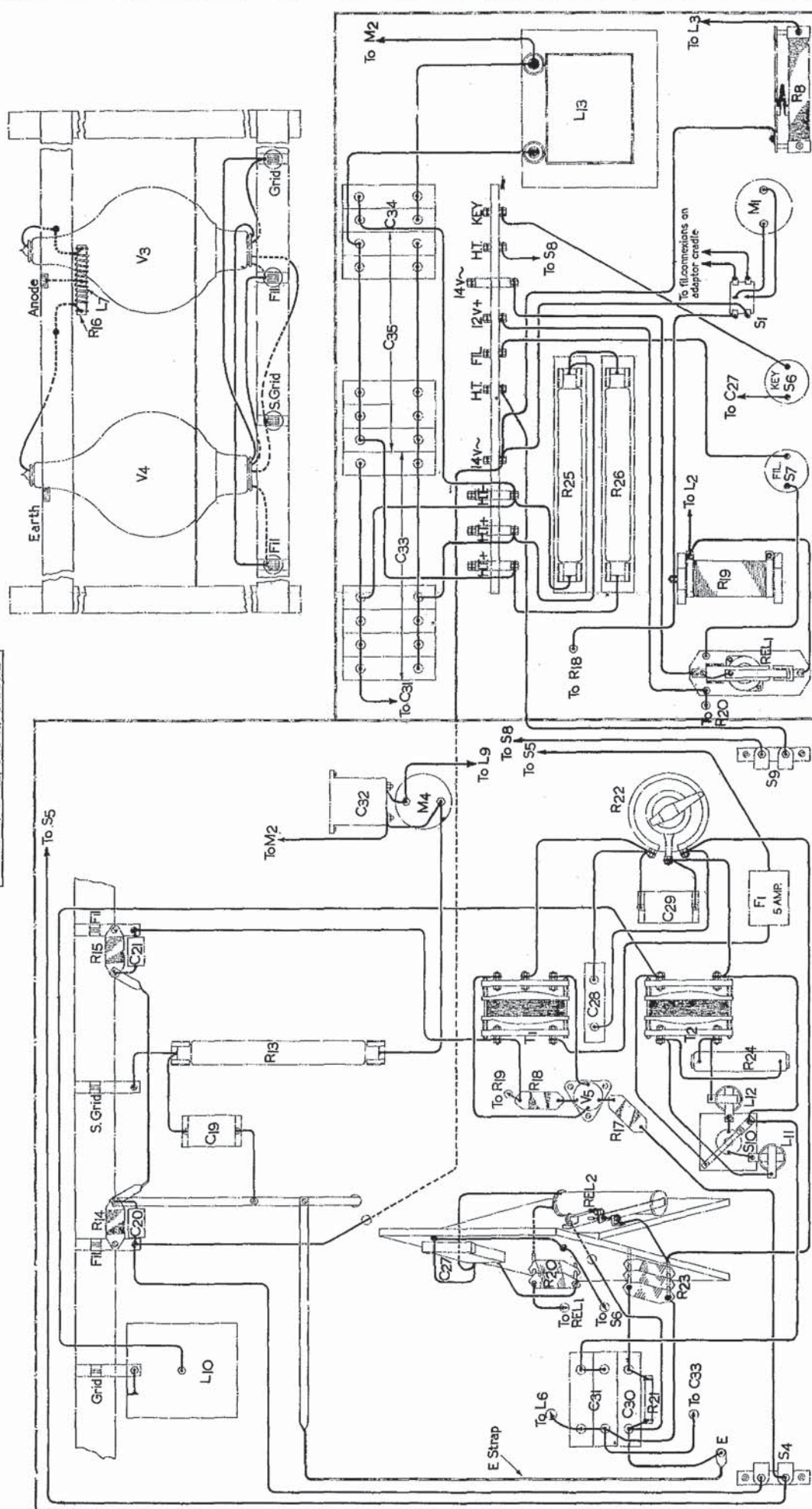


Fig. 9.—Control section from right-hand side

coil (2) is coil Q, the crystal oscillator anode coil which corresponds to L_1 of fig. 2. The "C" contacts (3) are designed to engage with the cylindrical contacts of the adaptor, type 15, and holder, type 126. A terminal (4) is provided to effect rapid change to M/O working. A strip connector (5) engages with an adaptor terminal (4, fig. 12). The connector (6) is used to parallel the condenser C_{18} for 1.5 Mc/s to 3.0 Mc/s working. The flexible lead (7) is a filament connector for V_2 .





BENCH WIRING DIAGRAM OF CONTROL AND GRID BIAS UNIT

FIG. 11

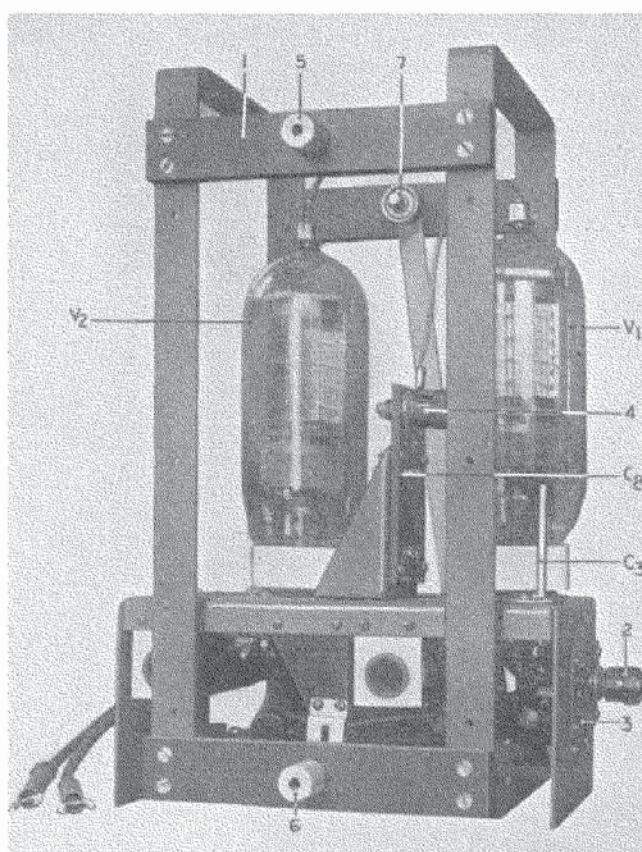


Fig. 12.—The adaptor, type 15

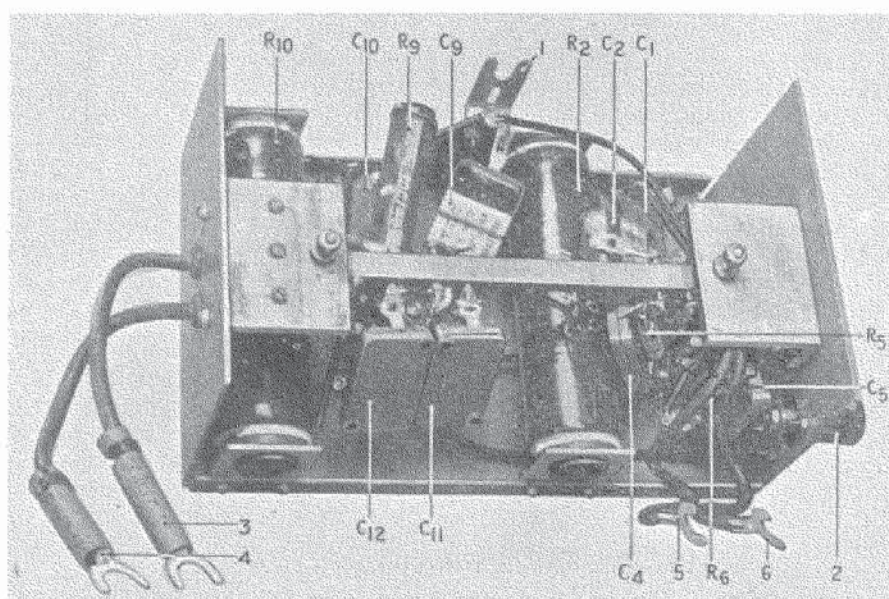


Fig. 13.—Underside of the adaptor

The adaptor, type 15

37. The adaptor, type 15, mounted in its special crate or holder (1) is shown in fig. 12. The adaptor is inserted in the body of the transmitter with the small paxolin panel carrying the filament terminal (2) and crystal holder sockets (3) to the front. The terminal (2) is connected to the filament switch S_2 . The adaptor is inserted through the door (8, fig. 1) on the front panel. The anode of V_1 is connected to the terminal (4) on the adaptor. The anode of V_2 is connected to the holder anode terminal (5). The grid connector (6) and a filament terminal (7) are also visible.

38. An underside view of the adaptor, type 15, is given in fig. 13 and a bench wiring diagram in fig. 14. The connector (1) at top centre of the illustration is the grid connector. The terminal (2) is the filament terminal for V_2 . The flexible leads (3) and (4) are screen connectors for V_1 and V_2 respectively. The tagged connectors (5) and (6) are filament leads. An illustration of the amplifier valve holder, type O, is given in fig. 15. The asbestos covered valve clips (1) are secured by terminal nuts (not shown). The earth contact (2) is not used in this application.

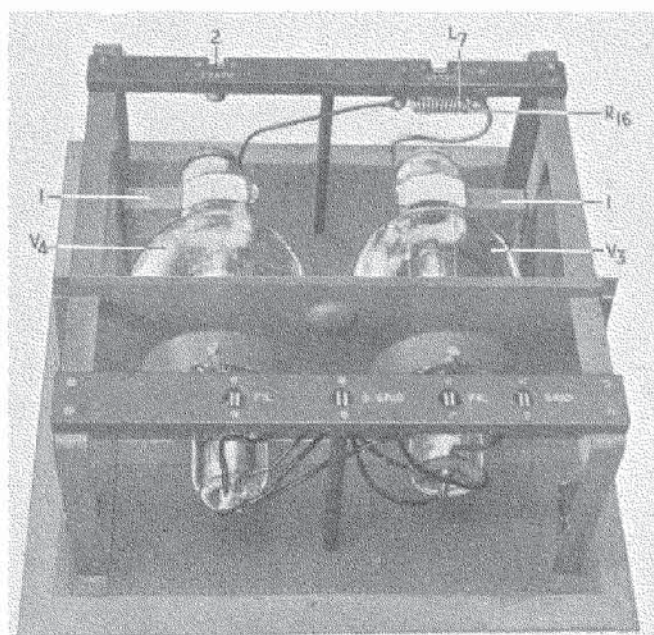


Fig. 15.—The valve-holder, type O

Coils

39. The special construction of coils and holders enables a minimum of the former to be used for full coverage. The interchangeable coils are equipped with plugs and the holders with sockets whereby the appropriate circuits are selected. The coils P and Q are wound with 16 s.w.g. wire or ceramic formers. A paxolin base incorporates five plugs which are inserted into five sockets in a ceramic holder which is a part of the condenser C_6 . The coils used for L_1 are wound with copper tubing, the tapping plugs, according to the required inductance, being soldered to the appropriate turns. The tapping plugs connect to the appropriate sockets of a seven-point holder, one connexion of which is enlarged to serve as a key. The coil R and S, represented by two sets ofappings, is wound of $\frac{1}{4}$ in. copper tubing on a low-loss former, the coil M and N being of similar construction. The coil G, H and K is wound of $\frac{3}{8}$ in. tube.

40. The amplifier coil L_8 (see fig. 8) is wound of $\frac{1}{4}$ in. copper tubing and has eight tapping switches lettered A to H on the anode side, with six on the output side. Switches lettered C and F split the coil into three sections. The coil for balanced lines L_{14} is wound of copper tubing and is plug-tapped at every half turn. There are nineappings lettered A to J, on either side of the centre (earth) tapping on the input side. Eighteenappings, similarly arranged and lettered constitute the the output side of L_4 .

VALVES AND POWER SUPPLIES

41. Four valves are normally used in the T.1190 with three rectifier valves. Two thoriated tungsten filament constant voltage-type pentodes of the type V.T.96 are used in the adaptor, type 15, as crystal-oscillator and frequency-doubler respectively. These are directly-heated and rated for

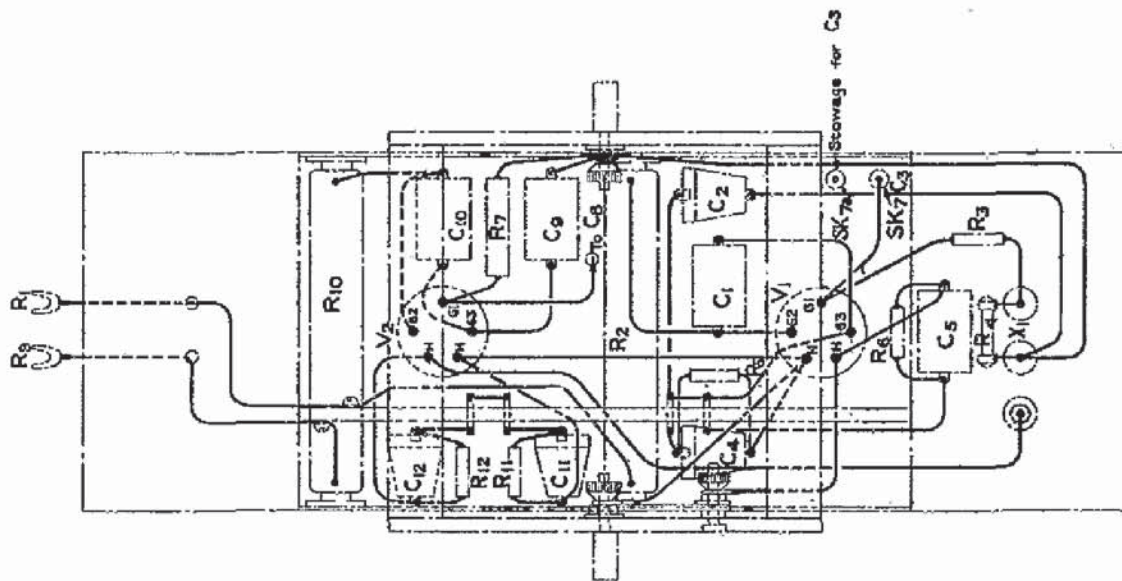


FIG. 14

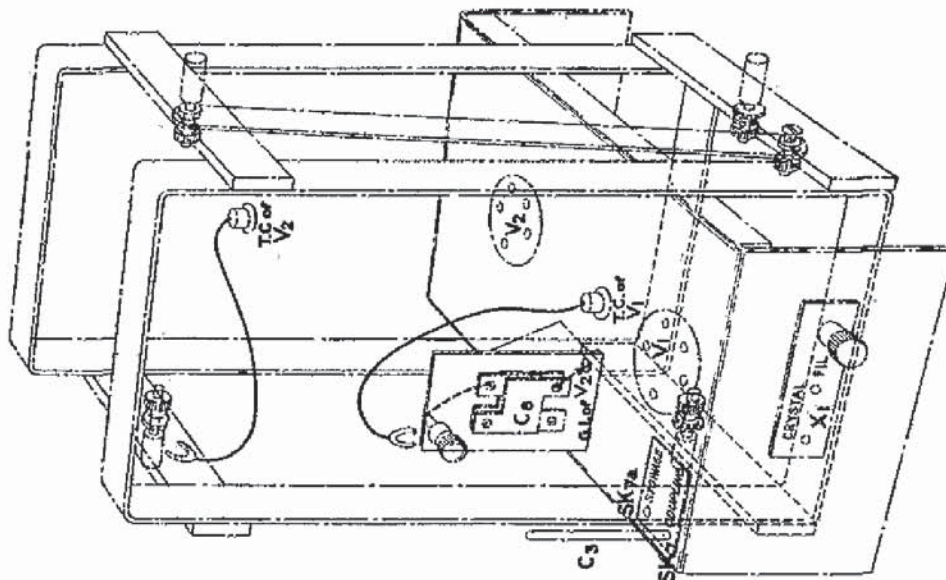
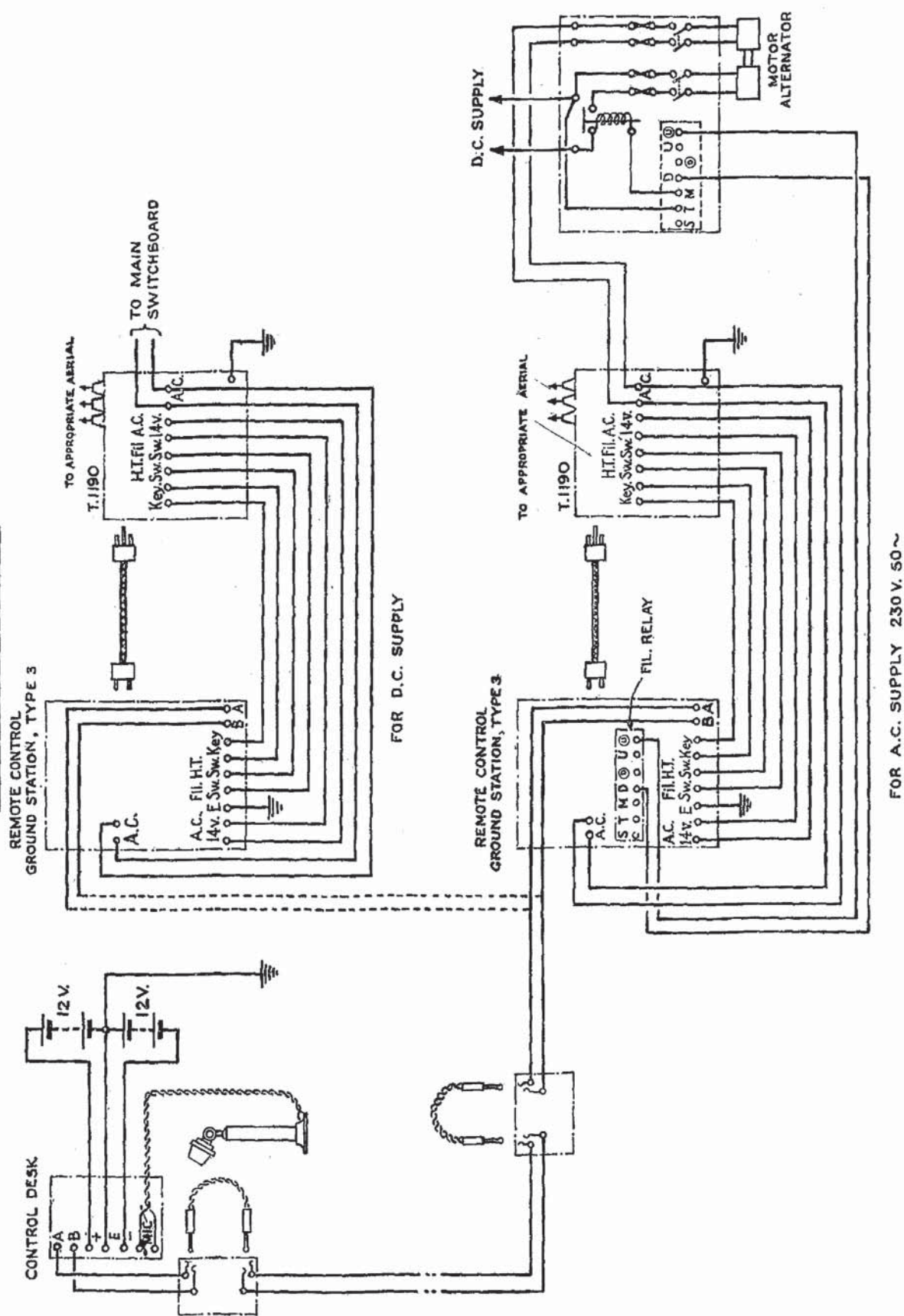
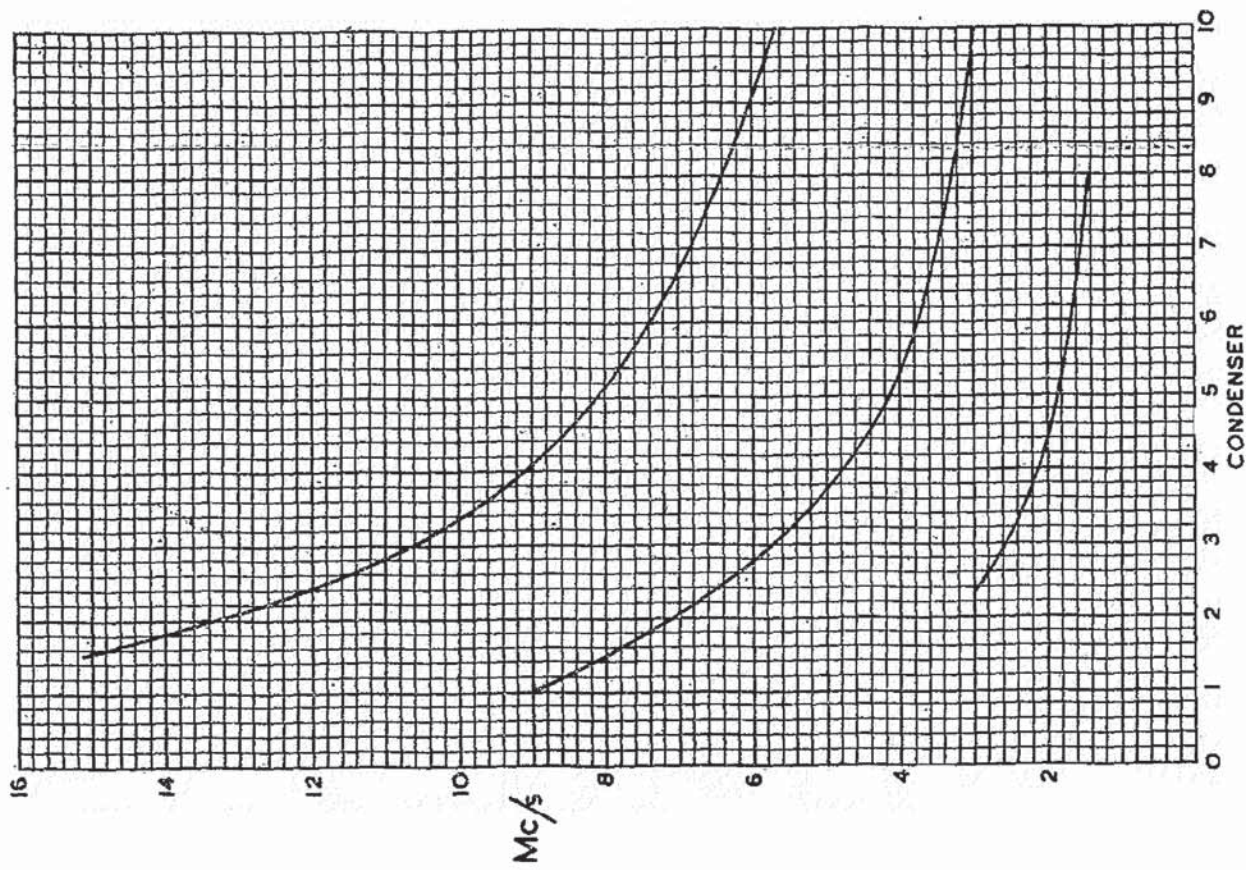


FIG. 14

BENCH WIRING DIAGRAM OF ADAPTOR, TYPE 15



TYPICAL INSTALLATION DIAGRAM



INTERPOLATION CURVE FOR
M/O TUNING

FIG. 17

FIG. 17

12 volts. They have a control-grid-anode capacitance of $0.03\mu\text{F}$, input capacitance $15\mu\mu\text{F}$ and output capacitance $10\mu\mu\text{F}$. The limits of voltage are 1,500 v. anode, 300 v. screen and 45 v. on the suppressor grid which, in this circuit, however, is earthed. Maximum anode dissipation 60 watts, screen 20 watts.

42. The two parallel amplifier valves are directly heated tetrodes of the type V.T.31. These are contained in the valve holder, type O. They are of the same type as is used in the T.1087. The rectifier valve is of the full-wave type V.U.39. The power is normally obtained from a 230-volt, 50 cycle A.C. supply but D.C. may also be used in conjunction with a motor alternator or suitable converter. Filament transformers in the rectifier panel are tapped for voltages 150 v. to 230 v.

INSTALLATION

43. The transmitter can be operated locally or, as is normal, by means of remote control. For R/T or M.C.W. the amplifier A.1104 of the remote control, type 3, is essential. The diagram of fig. 16 shows a typical installation. The installation of the transmitter can be regarded as identical with that of the T.1087, except for the additional provision for coaxial cable working *via* Sk₆, and reference should be made to the chapter upon that instrument.

44. The T.1190 is normally intended to be worked into a quarter-wave vertical or inclined aerial system fed by coaxial cable which is connected to the socket Sk₆ (*see* fig. 7). It may also be used for direct aerial (2, fig. 7) or balanced 600-ohm feeder lines, as shown set up in fig. 7. The latter will seldom be used owing to the difficulty of erection of the feeder line. The quarter-wave aerial must be cut from R4 aerial wire in accordance with the formula $l = \frac{240}{f}$ where f equals the operating frequency in megacycles and l the length of the aerial in feet.

OPERATION

45. In the first instance the operator should ensure that the adaptor, type 15, is in position and correctly connected. Reference should be made to the illustrations figs. 1, 6, 10, 12 and 13 which will materially assist. The anode of V₁ should be connected to the anode terminal (4, fig. 12) with braided flexible lead. The anode of V₂ should be joined to the other anode terminal (5, fig. 12). The screen connectors of V₁ and V₂ (*see* fig. 13) should be connected to the nuts at the bottom ends of R₁ and R₂ respectively, as shown in fig. 6, (5) and (6). The filament leads (5) and (6) shown in fig. 13 join to two terminals marked FILAMENT at the bottom of the adaptor holder. The third, or switched filament, connexion (7, fig. 9) joins to the filament terminal (2, fig. 12).

46. The adaptor is inserted with the crystal holder sockets to the front, the cylindrical contacts being pressed well home in the "C" sockets on the transmitter frame (3, fig. 9). It should be appreciated that the filament connexions shown in fig. 13 (5) and (6) must be made before inserting the holder. The grid connexion (1, fig. 13) is made to a terminal (6, fig. 12) and must be tightened before insertion. The valves V₁ and V₂ are inserted in their sockets and the top caps connected.

47. The amplifier valves V₃ and V₄ are inserted in the holder, type O. The asbestos clamp must be removed, this being effected by loosening terminal nuts. The flexible leads to the holder are secured by terminals which are engraved in accordance with fig. 15. If necessary the leads should be extended by the use of R4 wire and insulated sleeving. Before inserting the holder, type O, the grid bias rectifier valve V₅, type V.U.39, must be inserted (*see* fig. 8). The holder, type O, is then pushed into position making sure that the contacts are properly engaged. The rectifier valves, type V.U.29, are then inserted in position *via* the door at the bottom left-hand corner of the main panel (*see* fig. 1).

48. The fuses should next be checked. The bias valve fuse is F₁ and access to this is obtained by removing the amplifier valve holder, type O. A spare fuse, type D, is provided. The rectifier fuses are shown in fig. 1. These consist each of two strands of 33 s.w.g. tin wire (8, fig. 1). The rectifier pilot lamp should be in position. This is also inserted through the door mentioned in para. 32. The H.T. voltage switch (3, fig. 1) is set to stud 1 (1,600 volts.)

49. The appropriate aerial should next be connected. If 600-ohm lines are to be used the feeder lines should be joined to the two outer terminals (7, fig. 6; 9, fig. 1). If using direct aerial the centre terminal (2, fig. 7) is used. The coaxial cable working necessitates that the connector (1, fig. 7) should be removed from the centre terminal and connected to the coaxial socket Sk₆. The plug terminating the coaxial cable must be inserted in Sk₆. Ensure that the frame earth connexion is made (8, fig. 6) and that the A.C. supply is connected.

Frequencing-doubling (3 Mc/s–15 Mc/s) C.W.

50. Insert crystal unit in socket on the adaptor (3, fig. 12). The crystal fundamental frequency corresponds to the reference number engraved on the unit. This should be half the desired operating frequency. If the crystal is between 1.5 Mc/s and 4 Mc/s the feed-back rod, constituting the condenser C₃, should be inserted in the socket Sk₇ marked COUPLING, otherwise this rod is retained in the stowage socket Sk_{7n}.

TABLE I

TYPICAL SETTINGS OF T.1190 WHEN WORKING INTO UNBALANCED LOAD OF 50 OHMS

RANGE 3-15 Mc/s

Amplifier grid bias set at zero, that is, C.W. setting
Output frequency = 2x Crystal frequency

Frequency Mc/s	Oscillator			Doubler		Oscillator and Doubler Anode Current M ₂	Amplifier			Series Coupling Condenser C ₂₅	H.T. Stud	Amplifier Input M.A. M ₄	Output Amps M ₅
	Coil L ₁	Condenser C ₅	Anode Current M.A. M ₂	Coil L ₄	Condenser C ₁₈		Anode Tap L ₈	Coupling Tap	Condenser C ₃₂				
3-10	Q	75	45	M	8-21	85	CFH	O	3-65	105	2	220	2-30
3-46	Q	60	45	M	6-46	85	CFH	O	3-00	96	2	230	2-32
4-00	Q	45	45	M	4-68	85	CFG	N	4-04	88	2	230	2-20
4-72	Q	33	45	M	3-24	85	CFG	N	1-79	73	2	235	2-30
5-60	Q	25	45	M	2-35	85	CE	N	1-40	53	2	235	2-20
6-34	Q	18	45	M	1-49	85	CD	M	4-70	58	2	250	2-20
6-82	Q	16	52	G	8-04	115	CD	M	3-68	52	3	250	2-20
8-00	Q	10	52	G	5-69	115	CD	M	1-69	44	3	240	2-10
9-00	Q	5	60	G	4-38	115	B	L	4-33	42	3	260	2-10
10-00	P	34	58	G	3-48	120	B	L	3-07	35	3	255	2-20
11-18	P	27	56	G	2-60	118	B	L	1-90	29	3	230	2-15
12-00	P	22	60	G	2-14	119	A	K	5-47	27	3	290	1-50
13-00	P	19	60	G	1-65	119	A	K	4-44	23	3	260	1-60
14-00	P	15	57	G	1-20	118	A	K	3-56	20	3	300	1-75
14-88	P	12-5	57	H	3-24	118	A	J	3-13	56	3	270	1-60

51. Select and insert the appropriate coils for the desired frequency in accordance with the accompanying Table 1. The coils corresponding to L_1 occupy the position indicated as (2) on fig. 9 and coils represented by L_4 the position indicated as (1) on the same illustration. Ensure that the wide connecting strip on the coil L_4 engages with the wide socket on the coil holder (8, fig. 9). The tapping switches for the amplifier coil L_3 should be set in accordance with Table 1 which gives typical settings for working into an unbalanced load of 50 ohms.

52. The coaxial cable working the flexible connectors associated with the output circuit are arranged as follows:—Referring to fig. 7, the connector (6) should go to the direct connexion of the coupling unit, type 14 (5). The opposite end of this connector, Sk_3 , goes to the plug end of the connector (7) the opposite end of which is Sk_5 . This socket Sk_5 goes to the stowage plug which will be found at the rear centre of condenser C_{26} . The connector (3, fig. 8) which terminates in Sk_4 is joined to the plug on the thermo-ammeter M_3 .

53. Set the bias unit control R_{22} to maximum scale reading, that is, fully clockwise. The filaments may now be switched by means of the rectifier filament switch (3, fig. 1) and S_7 . A thermal delay switch is included in the filament circuit to prevent the H.T. being switched ON until the rectifier filaments are sufficiently warm.

NOTE.—If new rectifier valves are used, allow 15 minutes before switching ON H.T. for the first time. Approximately 60 seconds after the filaments are switched on the H.T. switch (4, fig. 1) may be applied.

54. The frequency-doubler valve V_3 filament switch S_2 should be in the OFF position before attempting to tune the T.1190. During the interval of waiting for the thermal relay to operate the filament voltages of V_1 , V_3 and V_4 should be adjusted to 12.0 volts for V_1 and 11.50 volts for V_3 and V_4 by means of the voltmeter M_1 which is switched into the filament circuits by S_1 . The voltage adjustment is performed by R_8 or R_{19} whichever may apply.

55. The condenser settings and coil tapings should now be made in accordance with the Table 1 with the exception of the aerial series condenser C_{26} which should be initially set to zero. The H.T. may now be applied by the switch annotated as (4) on fig. 1.

56. Slowly rotate C_8 until the needle of the milliammeter M_2 "kicks" downwards. Tune to the bottom of this dip and note feed current by M_2 . Rotate C_8 towards zero until the feed current increases by 5 milliamps. The crystal oscillator may now be regarded as set up. Switch V_2 into circuit by means of S_2 and readjust the filament volts by R_8 to 12 volts. Adjust R_{22} until the milliammeter M_4 reads approximately 30 mA.

57. Rotate C_{18} until M_2 dips downwards, at the same time the current as read on M_4 will rise. Then adjust C_{18} for MAXIMUM reading on M_4 . It will be noted that this corresponds to minimum current on M_2 . The frequency doubler stage is now correctly tuned.

58. The amplifier stage V_3 and V_4 may now be set up by means of C_{23} . Rotate the control of this condenser until M_4 "kicks" downwards and adjust for minimum current. The bias may now be decreased by R_{22} to position 3 on the 0-8 scale or an appropriate position on a substitute scale if fitted. Increase C_{26} by steps of 10 degrees, returning to C_{22} each time, until M_4 reads 100 mA. Set R_{22} to zero. The H.T. tapping switch (2, fig. 1) may now be set to stud 2 or stud 3 to give the desired output, say 2 amps, as read on M_3 , into coaxial cable. It may be necessary to readjust the coupling condenser C_{26} and tuning condenser C_{22} to obtain optimum efficiency. In the range 1.5 Mc/s to 3 Mc/s the H.T. tapping switch should not exceed stud 2 in any circumstances. This corresponds to a power of 250 watts. Should a higher or lower impedance aerial be used the current will correspondingly decrease or increase. **NOTE.**—The meter M_3 is out of circuit when using 600-ohm feeder lines.

Crystal fundamental operation into coaxial cable

59. In order to work on crystal fundamental the following slight circuit alterations are necessary:—

- (i) The screen lead (3, fig. 13) of V_1 should be connected to the bottom end of R_9 (6, fig. 6).
- (ii) The screen lead (4, fig. 13) is left disconnected.
- (iii) The anode connector is removed from V_2 and placed on the top cap of V_1 . The anode connector of V_1 should be removed and placed in the coil transit case.
- (iv) The filament of V_2 should be switched OFF by S_2 .
- (v) The ceramic coils (L_1) are not required and should be omitted from the transmitter.
- (vi) Remove the resistance R_1 .

60. Ensure that the filament voltages are correct and that the bias control of R_{22} is set to maximum before switching on the H.T. The condenser C_8 should be left at zero. The crystal oscillator is now tuned by C_{18} in accordance with Table 2 or Table 3. When C_{18} is rotated the milliammeter M_2 will "kick" downwards as described in para. 56. NOTE.—Do not omit to off-set the crystal tuning towards zero until the feed increases 5 mA above the MINIMUM reading on M_2 . The tuning of the amplifier stage is identical with that for frequency-doubler operation. The Table 2 gives typical settings when working into unbalanced load of 50 ohms in the range 1.5 Mc/s to 3 Mc/s. Table 3 is a similar table for the range extended to 7.5 Mc/s.

TABLE 2

TYPICAL SETTINGS OF T.1190 WHEN WORKING INTO UNBALANCED LOAD OF 50 OHMS
RANGE 1.5–3 Mc/s

Amplifier grid bias set at zero, that is, C.W. setting.

Output frequency = Crystal frequency.

H.T. Tap stud 2 should not be exceeded on this range.

Condenser C_{18} .—Both sections in parallel by means of link.

Condenser C_{22} .—Both sections in parallel by means of link and switch.

Output Frequency = Crystal Frequency Mc/s	Oscillator			Amplifier			Series Coupling Condenser C_{26}	H.T. Stud	Amplifier Input M.A. M_1	Output Amps. M_3
	Coil	Condenser	Anode Current M.A. M_2	Anode Taps	Coupling Tap	Con- denser				
	L_4	C_{18}		L_3		C_{22}				
1.5	R R	6.70	65	CFH	O	7.94	180	2	180	2.00
1.73	R	5.40	65	CFH	O	6.18	180	2	200	2.10
2.00	R	4.16	65	CFH	O	4.42	165	2	220	2.30
2.410	R	2.94	65	CFH	O	2.80	149	2	250	2.30
2.70	R	2.37	63	CFH	O	2.13	126	2	235	2.30
3.17	R	1.75	60	CFH	O	1.36	104	2	225	2.30

TABLE 3

TYPICAL SETTINGS OF T.1190 WHEN WORKING INTO UNBALANCED LOAD OF 50 OHMS
RANGE 3–7 Mc/s

Amplifier grid bias set at zero, that is, C.W. setting

Output frequency = Crystal frequency

Output Frequency = Crystal Frequency Mc/s	Oscillator			Amplifier			Series Coupling Condenser C_{26}	H.T. Stud	Amplifier Input M.A. M_1	Output Amps. M
	Coil	Condenser	Anode Current M.A. M_2	Anode Taps	Coupling Tap	Con- denser				
	L_4	C_{18}		L_3		C_{22}				
3.17	M	7.78	62	CFH	O	3.60	103	2	220	2.3
3.41	M	6.61	62	CFH	O	2.55	92	2	210	2.3
4.00	M	4.64	62	CFG	N	4.18	86	2	230	2.2
4.50	M	3.84	62	CFG	N	2.58	75	2	225	2.3
5.00	M	2.78	62	CE	M	3.32	56	2	220	2.1
5.59	M	2.10	62	CE	M	1.75	52	2	220	1.9
6.00	M	1.73	62	CD	M	5.80	57	2	220	2.1
6.50	M	1.32	63	GD	M	4.52	53	2	220	1.9
7.0	G	7.54	62	CD	M	3.42	49	2	200	1.4

Master-oscillator operation into coaxial cable

61. In order to utilise the T.1190 for the M/O working on frequencies for which crystals are not available, the following circuitual alterations must be effected:—

Assuming the T.1190 is set up for frequency doubling

- (i) Remove V_1
- (ii) Connect terminal (4, fig. 12) to terminal (4, fig. 9) by means of the connecting link found in the lid of the coil transit case.

62. The tuning is affected by the condenser C_{18} , the coil corresponding to L_1 being inserted for the appropriate range and the frequency selected from the calibration curves, fig. 17. The amplifier taps may be selected from Tables 1, 2 or 3 and the stage tuned as before. The output frequency should be checked by means of a wavemeter, such as the W.1117. Any slight difference should be adjusted by the tuning controls. If the frequency is too low C_{18} should be decreased. The output power will be slightly less on M/O working.

Operation into 600-ohm balanced lines

63. The circuitual changes necessary to operate into 600-ohm balanced lines, are illustrated in figs. 7 and 8. The changes to be effected are as follows:—

- (i) Remove connector (1, fig. 8) from direct connexion for the coupling unit (2, fig. 8) and place on the lower condenser for frequencies between 3 Mc/s and 12 Mc/s; place on the upper condenser for 12 Mc/s to 15 Mc/s.
- (ii) The socket Sk_3 should be plugged on to the coil L_{14} in accordance with Table 4 which gives typical settings.
- (iii) The connector (3, fig. 8) is removed from M_3 and plugged on to coil tapping as indicated in Table 4.
- (iv) The connector (7, fig. 7) is removed from stowage plug on C_{28} and placed on coil tap as per Table 4.
- (v) The connectors (3) and (4), fig. 7, are also made to appropriate taps on coil L_{14} .

64. The crystal-oscillator and doubler stages V_1 and V_2 are tuned as before. The condenser C_{22} is tuned for MINIMUM feed. The condenser C_{28} is rotated until the current on both feeder lines is equal as indicated by external meters (0 to 1 amp. thermo-junction meter). The coupling may be adjusted by moving Sk_3 one tap at a time on L_{14} and adjusting C_{22} .

R/T operation

65. The T.1190 should be set up for normal C.W. and tuned to maximum output. Having the set T.1190 to maximum C.W. output, the bias control R_{22} should be increased until the aerial ammeter M_3 reads half the current obtained with zero bias. Make sure that the connecting link between the A.1104 and T.1190 is plugged in the switch socket S_{10} (see fig. 8). The ON-OFF switch on the front panel of the A.1104 should be switched ON. The triple-ganged switch on the type 3 remote control should be set to R/T. The attenuator control on the A.1104 should be placed at MINIMUM.

66. Plug the desk-type carbon microphone into the socket on the local control panel of the type 3 remote control. The four-position switch on this panel should be set to LOCAL CONTROL. Decrease the attenuation until a normal conversation tone speaking into the microphone causes the aerial current as indicated on M_3 to increase 20 per cent.

67. When using the transmitter on R/T over land-lines the switch on the local control panel should be set to 600-ohm input and the attenuator on the A.1104 decreased still further.

M.C.W. operation

68. If M.C.W. is required the switch on the A.1104 should be set to OSCILLATOR and the attenuator adjusted to give a 20 per cent increase over half the maximum current obtainable. The transmitter is keyed in the normal manner.

PRECAUTIONS AND MAINTENANCE

69. It is essential that all contacts should be kept clean and periodically wiped over with petroleum jelly.

70. The filament voltages are critical and should always be maintained at the specified levels, that is 12 volts for V_1 and V_2 and 11.50 volts for V_3 and V_4 .

TABLE 4

TYPICAL SETTINGS OF T.1190 WHEN WORKING INTO BALANCED LOAD OF 600 OHMS

RANGE 3-15 Mc/s

Amplifier grid bias set at zero, that is, C₁W. setting
Output frequency = 2x Crystal frequency

Frequency Mc/s		Oscillator		Doubler		Amplifier			Fixed Coupling Con- denser μ F C ₃₄ or C ₃₅	Output Circuit					H.T. Stud	Amplifier Input M.A.	Output Amps.
Output	Crystal X ₁	Coil L ₁	Con- denser C ₆	Coil L ₄	Con- denser C ₁₃	Anode Tap L ₃	Coupling Tap	Con- denser C ₃₂	Coupling Tap	Output Taps			Condenser Taps		Con- denser C ₂₅	M ₄	M ₄
										Red	Yellow	Black	White				
3.10	1.55	Q	75	M	8.21	CFH	O	4.27	E Red	J	J	J	J	J	152	225	0.61
3.46	1.73	Q	60	M	6.46	CFH	O	2.40	E "	J	J	J	J	J	132	260	0.65
4.00	2.00	Q	45	M	4.68	CFG	N	4.20	D "	H	H	J	J	J	100	260	0.61
4.82	2.41	Q	32	M	3.12	CE	M	5.60	E "	H	H	H	H	H	84	250	0.60
5.40	2.70	Q	25	M	2.35	CE	M	3.79	D "	H	H	G	G	G	76	250	0.60
6.34	3.17	Q	18	M	1.49	CD	L	5.54	E "	H	H	G	G	G	63	240	0.61
6.82	3.41	Q	16	G	8.04	CD	L	4.39	D "	F	F	E	E	E	67	240	0.60
8.00	4.00	Q	10	G	5.69	CD	L	2.60	D "	F	F	E	E	E	58	220	0.60
9.00	4.5	Q	5	G	4.38	CD	L	1.29	D "	F	F	E	E	E	45	250	0.63
10.00	5.00	P	34	G	3.48	B	L	2.98	C "	F	F	E	E	E	42	300	0.65
11.18	5.58	P	27	G	2.60	B	K	2.05	D "	F	F	E	E	E	35	300	0.65
12.00	6.00	P	22	G	2.14	B	K	1.18	B	D	D	D	D	D	30	240	0.60
13.00	6.50	P	19	G	1.65	A	J	4.36	A	C	C	C	C	C	35	280	0.50
14.00	7.00	P	15	G	1.20	A	J	3.41	A	B	B	C	C	C	28	310	0.50
14.88	7.44	P	12.5	M	3.24	A	J	2.72	A	B	B	C	C	C	24	201	0.50

71. The mercury vapour valves in the rectifier should always be stored in an upright position. Should they by any chance be placed horizontally the filaments should be allowed to heat for at least 15 minutes before the H.T. is switched ON.

72. The grid bias rectifier valve V_6 will not operate until the filament has been ON for at least 30 seconds. Should the amplifier valve holder, type O, be removed for any reason, this time delay should be allowed before switching on the H.T. after replacing the holder.

73.* The transmitter doors must be shut before the H.T. can be switched ON. If the transmitter has been keyed the H.T. should be switched OFF and the key depressed before opening any doors in order to discharge the condensers.

74. Should the crystal fail to oscillate readily the length of the feed-back condenser rod (C_3) should be increased to 4 inches. This can be made up from a piece of 14 gauge copper wire. If this does not produce the desired effect V_1 and V_2 should be interchanged. If the crystal still fails to oscillate another crystal of the same frequency should be obtained. No endeavour should be made to dismantle the crystal unit.

75. When working the T.1190 as a frequency-doubler it may be noticed that decreasing the bias does not cause the increase in output current. This is due to the fact that the doubler stage is tuned to the crystal fundamental and not to the second harmonic. The doubling is taking place in the amplifier stage. The doubler tuning should be rotated towards zero until another tune point is found.

76. If, on applying S_7 , the filament switch, the transmitter valve filaments fail to light, the relay fuse, that is the top fuse seen in fig. 1, should be checked.

77. If the T.1190 is used purely for C.W. with local control do not forget to link the terminals at the rear of the transmitter, engraved FILAMENT SWITCHING and H.T. SWITCHING, with wire. The key should be connected between the terminals engraved KEY.

*Note.—Switch off the H.T. before making any changes which necessitate opening the doors of the transmitter. Do not rely wholly on the safety door switches. Although these switches isolate the power supply, the condensers of large capacity in various parts of the circuit take a few seconds to discharge. A period of 15 to 20 seconds should therefore be allowed to elapse after switching off and opening the doors, before any adjustments are made inside the transmitter. On C.W. or M.C.W. the condensers may be discharged by tapping the key, but even then allow the safety period to elapse. Always see that the main H.T. switch is off before unscrewing any of the side or back panels. (A.L.61)

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this transmitter the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/320	Transmitter, type T.1190			Without valve or indicating lamp
	Principal components:—			
10A/12051	Adaptor, type 15	1		See below
10A/7180	Ammeter, thermo, type A	1	M ₃	0-6 mA
5C/445	Box, fuse, type A	1		For F ₁
10D/365	Case transit	1		For inductance, type 165-168
	Choke, H.F.			
0C/8716	Type 22	1	L ₁₀	
0C/8718	Type 23	1	L ₂	
0C/9514	Type 35	2	L ₁₁ , L ₁₃	
0C/10986	Type 43	1	L ₈	
	Condenser			
0C/8098	Type 156	3	C ₁₇ , C ₂₇ , C ₃₂	1 μ F
10C/9163	Type 151	2	C ₂₃ , C ₇	0.01 μ F
10C/8170	Type 158	2	C ₁₄ , C ₂₄	50 μ μ F
10C/8496	Type 188	3	C ₁₉ , C ₂₀ , C ₂₁	0.01 μ F
10C/8720	Type 218	2	C ₁₈ , C ₃₅	0.00083 μ F bar.
10C/8721	Type 219	1	C ₂₅	0.0001 μ F
10C/9152	Type 264	1	C ₆	0.0001 μ F var.
10C/10920	Type 428	15	C ₃₀ (1), C ₃₁ (2), C ₃₃ (5), C ₃₄ (2), C ₃₅ (5)	1.5 μ F
10C/3551	Type 1766	1	C ₂₂	Var. with switch
10C/2162	Type—	1	C ₂₈	4 μ F
	Connector			
10H/0163	Type 4	2		
10H/976	Type 404	1		
10H/977	Type 405	2		
10H/1110	Type 424	1		
10H/1270	Type 449	1		
	Coupling Unit, type 14	1		Fitted with
			C ₃₄ , C ₂₅	Condenser 10C/8170, type 158, 50 μ μ F 10C/8721, type 219, 0.0001 μ μ F
5C/515	Fuse, type D	2	F	
10D/334	Grid bias unit, type 9			
	Consisting of:—			
10C/8163	Condenser, type 151	1	C ₂₃	0.01 μ F
10C/1681	Resistance, type 1681	1	R ₂₂	17,000 ohms
	Handle, vernier drive			
10A/7719	Type B	1		For C ₆ , ratio 50:1
10A/8723	Type E	2		For C ₁₈ , C ₂₂ , ratio 20:1
10A/12673	Type 7	1		For C ₂₉ , ratio 50:1
	Holder			
10H/619	Coil, type 3	1		1
10H/617	Resistance, type 4	1		31
10H/618	Resistance, type 5	1		31
10H/8173	Valve, type G	1		91
10H/1062	Valve, type 126	1		
10H/1063	Valve, type 127	1		Frame for adaptor, type 15
	Inductance			
10C/2910	Type 163	1	L ₁₄	
10C/2911	Type 164	1	L ₈	
10C/2912	Type 165	1	L ₂	
10C/2913	Type 166	1	L ₁	
10C/2914	Type 167	1	L ₄	
10C/2915	Type 158	1	L ₁	
10B/8093	Insulator, type 16	3		Aerial terminals

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter, type T.1190 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Milliammeter			
10A/3091	Type A	1	M ₂	0-300 mA
10A/3092	Type A	1	M ₄	0-500 mA
	Mounting			
10A/8803	Type 1	3		
10A/12683	Type 89	1		
10A/12681	Type 90	1		
10D/11156	Panel, type 11	1		Part of rectifier, type B
10C/2229	Pillar, mounting	4		
	Plug			
10H/1060	Type 290	1		
10H/1061	Type 291	2		
	Relay, magnetic			
10F/8254	Type M	1	REL ₁	
10F/8726	Type O	1	REL ₂	Spares:—10F/8727, Contact No. 1
	Resistance			
10C/7766	Type 82	5	R ₁₄ , R ₁₅ , R ₂₃ (3)	40 ohms
10C/8176	Type 127	1	R ₂	2 ohms
10C/7633	Type 190	1	R ₁₉	0.4 ohms var.
10C/9816	Type 302	2	R ₁₅ , R ₂₆	50,000 ohms
10C/9823	Type 309	1	R ₁₃	100,000 ohms
10C/9824	Type 310	1	R ₆	20,000 ohms
10C/9863	Type 324	1	R ₁₄	15,000 ohms
10C/40	Type 555	1	R ₇	100,000 ohms
10C/1599	Type 1599	1	R ₁	40,000 ohms
10C/1659	Type 1659	1	R ₈	1.7 ohms var.
10C/6212	Type —	1	R ₂₁	0.5 M ohms
10C/6213	Type —	2	R ₁₇ , R ₁₈	1.4 ohms
10H/160	Socket, type 86	1	Sk ₆	Coaxial
10C/2227	Spindle, extension	1		
10A/12796	Supressor, type 17	2		Fitted with:— 10C/1932, Resistance, Type 1932, 250 ohms 10A/12796, Choke, H/F
	Switch			
5C/622	Tumbler	2	S ₆ , S ₇	
10F/8082	Type 75	4	S ₁ , S ₅ , S ₆ , S ₇	Gate switches
10F/8142	Type 77	1	S ₉	
10F/9162	Type 97	1	S ₁₀	Fitted with:— Socket, type 19 plug operated
10F/10338	Type 152	1	S ₂	
	Transformer			
10K/8737	Type 55	1	T ₁	
10K/9164	Type 57	1	T ₂	
	Voltmeter			
10A/8183	M.I type A	1	M ₁	0-15 v.
10A/7784	M.C. type A	1	M ₅ (if fitted)	0-3500 v.
	Adaptor, type 15			
	Consisting of:—			
	Condenser			
10C/7906	Type 125	4	C ₃ , C ₅ , C ₁₁ , C ₁₃	0.01 μ F
10C/10511	Type 378	2	C ₂ , C ₉	0.01 μ F
10C/336	Type 663	2	C ₁ , C ₁	0.0025 μ F
10H/202	Holder, valve, type 45	2		
	Resistance			
10C/9634	Type 272	1	R ₄	50,000 ohms
10C/11685	Type 519	1	R ₃	50 ohms
10C/40	Type 555	1	R ₇	100,000 ohms
10C/66	Type 566	4	R ₅ , R ₆ , R ₁₁ , R ₁₂	40 ohms
	Socket			
10H/209	Type 98	2		
10H/7227	Terminal, 4 B.A. type C	4		
10H/627	Connector link, type 268	1		
	Accessories:—			
10E/147	Valve, V.T.96	2	V ₁ , V ₂	

Ref. No.	Nomenclature	Qty	Ref. in. fig. 2	Remarks
	Transmitter, type T.1190 (<i>cont'd</i>) Principal components (<i>cont'd</i>) Accessories:—			
10A/9520	Amplifier, type A.1104	1		} See A.P.1186, Vol. I, Sect. 6, Chap. 6
10A/9521	Control remote, ground station, type 3	1		
10A/9522	Control remote, ground station, type 4	1		
6A/1219	Lamp, filament, 230 v. 16 C.P.	1		
10E/8087	Valve V.U.29	2		Rectifier
10E/147	V.T.96	2	V ₁ , V ₂	
10E/8739	V.T.31	2	V ₃ , V ₄	
10E/9600	V.U.39	1	V ₅	F.W. Rectifier

SECTION 1, CHAPTER 13

TRANSMITTER T.1333

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CONCISE DETAILS OF TRANSMITTER T.1333

PURPOSE OF EQUIPMENT	Emergency transmitter for use in dinghy or boat		
TYPE OF WAVE	C.W. or M.C.W.		
FREQUENCY RANGE	500 kc/s.		
FREQUENCY STABILITY	Not applicable		
CRYSTAL MULT. FACTOR	Not applicable		
PERCENTAGE MODULATION	Not applicable		
MAXIMUM SENSITIVITY	Not applicable		
SELECTIVITY	Not applicable		
OUTPUT IMPEDANCE	Not applicable		
AMPLIFIER CLASS	Not applicable		
MICROPHONE TYPE	Not applicable		
VALVES	V ₁ , oscillator type 6V6G (Stores Ref. 10E/349) V ₂ , modulator type 6J7G (Stores Ref. 10E/352)		
POWER INPUT	30 watts. L.T. 6 volts, H.T. 300 volts		
POWER OUTPUT	Approximately 5 watts		
STORES REF. NO.	10R/13002		
APPROXIMATE OVERALL DIMENSIONS	Length 10½ in.	Width 9 in.	Height 11 in.
WEIGHT	18 lb.		
ASSOCIATED EQUIPMENT	Balloon for support of aerial Hydrogen generator		

TRANSMITTER T.1333

(Stores Ref. 10R/13002)

INTRODUCTION

1. The purpose of the transmitting equipment described in this chapter is to enable one-way emergency communication to be made from a dinghy, boat, or other situation, with ship and shore stations. It is capable of transmitting morse S.O.S. signals automatically and continuously, or the transmitter can be keyed and any necessary message be transmitted. With automatic transmission, the S.O.S. signal (distress) is repeated three times and these are then followed by twelve long dashes, the sequence being continued so long as the transmitter is in operation. The equipment has primarily been designed to be operated from a rubber dinghy under emergency conditions and on this account it possesses several special features which are described in detail later. The spot frequency is 500 kc/s. (600 metres) crystal control and the transmitter provides either C.W. or M.C.W. service. The power output into the aerial is 5 watts and under the most suitable conditions the range is approximately 100 miles.

2. The equipment consists of three separate units as detailed below:—

- (i) Transmitter, including a hand-driven generator for all power supply, aerial wire and earth line.
- (ii) Rubber balloon for support of the aerial.
- (iii) Hydrogen generator for filling the aerial balloon with hydrogen.

3. A view showing the equipment being put into use is given in fig. 1. The transmitter is supported between the knees of the operator and with the aerial raised by the balloon and the earth line dropped into the water, after the transmitter is tuned, S.O.S. signals are sent out automatically by merely turning the handle of the power supply generator. Operation is therefore possible by one person, but it is facilitated by a second, particularly if it is required to transmit a message by keying.

4. The transmitter is watertight and will float. It can be dropped into the sea from a height of ten feet without injury and as it is enamelled a bright yellow colour it is easily discernible when in the water. It will not adversely be affected by altitudes up to 40,000 ft., by any temperature between +30 deg. C. and -20 deg. C. or by vibration of 10G in any plane at frequencies between 25 and 100 cycles per second. The weight of the complete transmitter, including 208 ft. of aerial wire and earth line and sinker is approximately 18 lb.

5. The hydrogen with which the balloon for the support of the aerial must be filled is generated by immersing a special canister containing calcium hydride to an indicated level in the water.

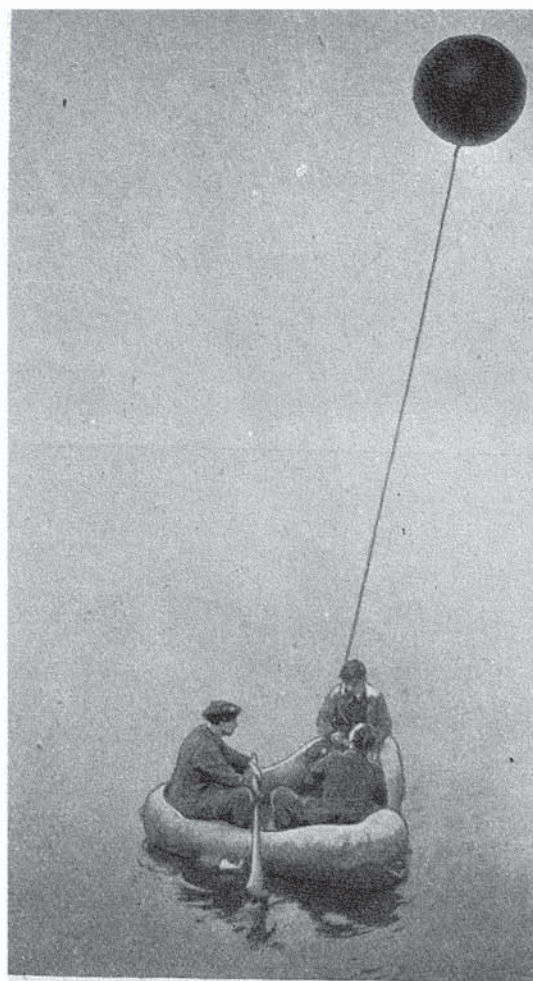


FIG. 1—VIEW OF EQUIPMENT IN DINGHY

GENERAL DESCRIPTION**Transmitter**

6. A view of the complete transmitter is given in fig. 2. It consists of a light steel case which contains the oscillator and modulator, the hand-driven generator for providing the L.T. and H.T. supplies, the voltage regulator, the interruptor, the selector and aerial and earth line. These units are described in detail later.

7. The circuit of the transmitter and power unit is given in fig. 3 and it will be seen that a beam power valve (type 6V6G) V_1 , is used as an electron-coupled crystal-controlled oscillator. The screen grid and cathode of this valve form the elements of an inverted Hartley oscillator with a crystal X_1 inserted in the grid circuit, thus forming a crystal locked circuit. Keying is accomplished by breaking the screen supply to the oscillator.

8. For use on M.C.W. an A.F. pentode modulator valve (type 6J7G) V_2 , is employed with a transformer T_1 to provide feed back between anode and grid circuits.

9. The primary of the transformer is capacity tuned to give a modulating tone of approximately 1,000 cycles per second. This is fed to the output stage valve V_1 , via the grid leak R_1 and R.F. choke (H.F.C.), by means of a tertiary winding on the transformer. The modulator valve V_2 is not keyed and oscillates continually when in circuit.

10. The aerial coil is capacity tuned and is provided with two taps which are selected by means of a switch which is integral with the tuning condenser spindle, the effect being approximately to double the tuning range of the variable condenser C_6 .

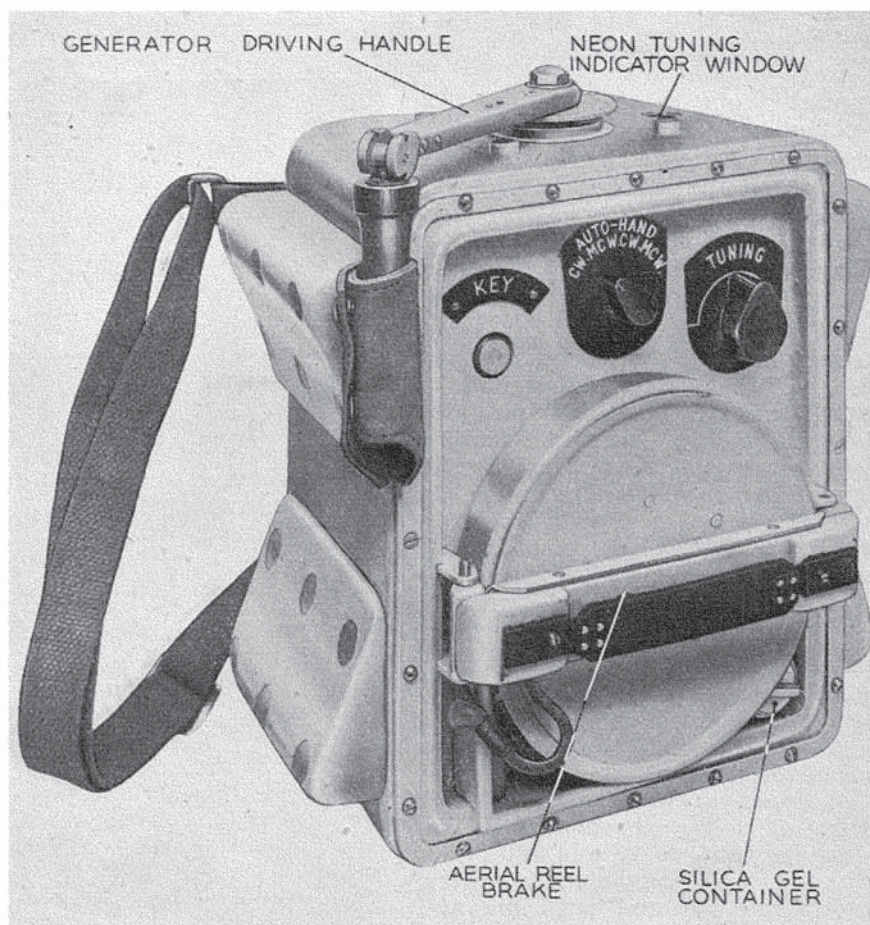


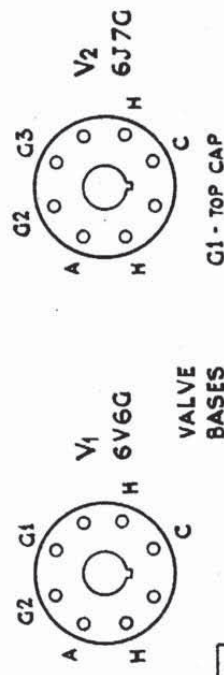
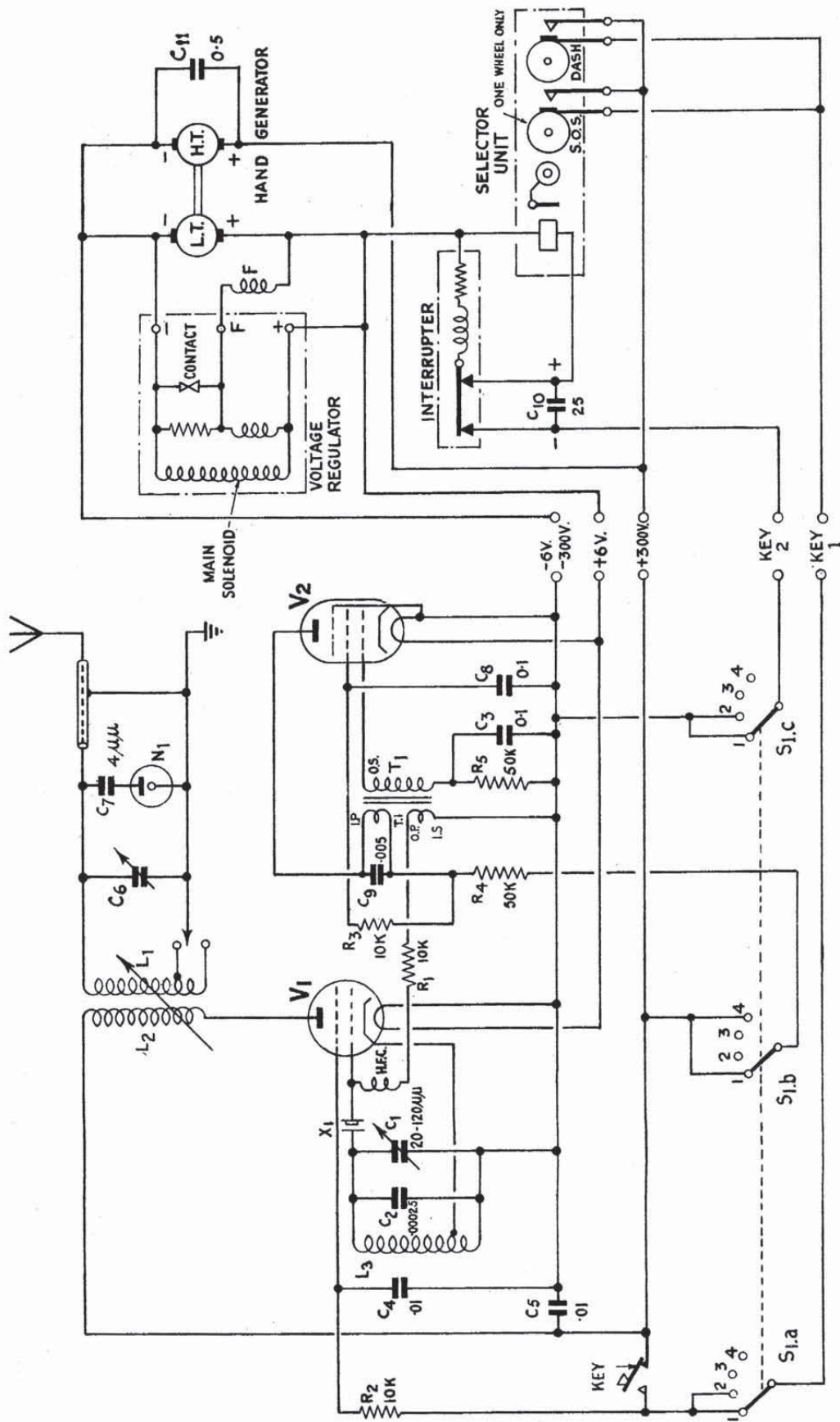
FIG. 2—VIEW OF TRANSMITTER T.1333

11. The aerial is connected to one end of the coil, the earth lead being connected to the other end.

12. Tuning indication is provided by a neon lamp N , which is connected in series with a small condenser C_7 across the aerial coil, maximum output being indicated at maximum lamp brilliance.

Power unit

13. The circuit of the hand-driven generator with its associated voltage regulator is also included in fig. 3. Included in this diagram are the circuits of the interrupter and selector units which are described later. Two outputs (300 volts H.T. and 6 volts L.T.) are provided by the generator, these being collected by the two pairs of brushes.



T.1333
CIRCUIT

FIG. 3

FIG. 3

Voltage regulator

14. The voltage regulator consists of a relay having an iron-cored bobbin carrying two inductive windings and one non-inductive winding. An armature, mounted on a stiff reed is tuned to a periodicity of approximately 1,000 cycles per second and carries a contact which in the non-operated state makes with a stationary self-centring contact. As the voltage rises across the L.T. brushes of the generator, the flux density of the relay core increases, attracts the armature and breaks the contacts, thus putting the 42-ohm resistance winding of the relay in series with the field winding F of the generator. Less current then flows in the field windings of the generator and this reduces the voltage across the L.T. brushes, with the result that the contacts make again. This cycle is repeated at the natural frequency of the armature of the relay. It will be clear that the lowered L.T. voltage will reduce the flux of the relay magnet owing to the smaller current flowing in the 55-ohm shunt winding. Since the regulator controls the common field winding of the generator, it governs both the L.T. and H.T. voltages and it can be adjusted to operate at a predetermined L.T. voltage.

Automatic keying mechanism

15. The automatic keying mechanism is for the purpose of automatically transmitting sequences of three S.O.S. signals followed by twelve long dashes. It consists of (a) a selector unit and (b) an interruptor which operates the selector unit.

Selector unit

16. The circuits of the selector unit and interruptor are included in fig. 3. The selector unit consists of a simple electro-magnetic relay which steps round a ratchet wheel. This in turn drives a wheel, the periphery of which is provided with two series of notches or grooves to produce three S.O.S. signals and four long dashes. This wheel is shown in two sections in the circuit diagram.

17. Two pairs of keying contacts, one operated by the S.O.S. and the other by the long dash grooves on the signal wheel are connected in parallel and break the H.T. feed to the R.F. oscillator valve screen.

18. The sequence of three S.O.S. signals and twelve long dashes is accomplished by means of two cams on a large toothed wheel geared to the signal wheel in the ratio of 1 to 4. These cams are so designed that for a quarter revolution of the large, toothed wheel, the S.O.S. contacts will come into operation, the long dash contacts being inoperative, while for the remaining three-quarters of a revolution the long dash contacts operate, the S.O.S. contacts now being inoperative.

Interruptor unit

19. The interruptor unit governs the periodicity of the impulses fed to the selector unit, irrespective of the supply voltage fluctuations. Its purpose therefore is to supply a series of timed impulses to drive the selector unit.

20. The unit consists of a small spring-controlled bobbin-shaped armature carrying a small coil wound at right angles to its axis and surrounded by a stator. This stator consists of eight short lengths of soft iron disposed circularly and held in place by being embedded in the material of the case containing the device. When the keying switch is set to AUTO, L.T. is applied to the armature coil, causing its ends to become oppositely polarised, whereupon the coil swings towards the soft iron pole pieces. This partial rotation of the armature breaks a pair of contacts in the L.T. supply when, due to the torsion of a spiral hair spring, the armature swings back and the contacts are again made, and the cycle repeated; this operation, which is similar to the oscillation of the balance wheel of a watch, is repeated at a rate of approximately 5 cycles per second.

21. Another pair of contacts which are also operated by the movement of the armature, make and break the L.T. supply to the relay of the selector unit which thus receives an impulse to step the signal wheel round at each oscillation cycle of the armature.

CONSTRUCTION

22. The transmitting equipment, which includes the transmitter, power unit, voltage regulator, automatic keying mechanism, aerial and earth line, is contained in a light steel case, the sides and bottom of which are pressings strengthened by ribbing.

23. Knee grips of moulded rubber are bolted to the two sides of the case which is also provided with a webbing strap for slinging over the shoulder of the operator.

24. The front panel, which is also a light steel pressing, is secured to the body of the case by twenty screws and a rubber gasket is fitted between the edges of the case and the panel. The case

is watertight, felt glands impregnated with oil being fitted at all spindle entries and blind holes being employed for all screws. A silica-gel drying unit is fitted which will absorb a limited amount of moisture which may get into the case, by condensation from the atmosphere. It will not cope with actual leakage of sea water.

25. On the front panel are the hand key, a service switch with four positions and aerial tuning knob, each being easily identifiable by a name plate with lettering in luminous paint which is radioactive and does not require previous exposure to light to become luminescent.

26. On the lower part of the front panel is an annular case with a hinged door containing the aerial reel. A series of projections are provided in the case round which are wound the aerial lead-in and earth line. The aerial consists of 208 ft. of stainless steel flexible wire, and the earth line, which is 10 ft. long, is provided with a sinker. A spring-loaded folding handle is fitted to the aerial reel and a brake button is fitted under the leather handle on the outside of the door. The door is secured, when closed, by a pin attached to the case by a leather thong. This pin is retained in position by a thin piece of soft wire threaded through a hole in the end and this can be sheared by the action of withdrawing the pin.

27. At the bottom right-hand corner of the front panel is the silica-gel drying unit which is provided with a cap and by the removal of this, access can be had to the drying element for renewal or revitalisation.

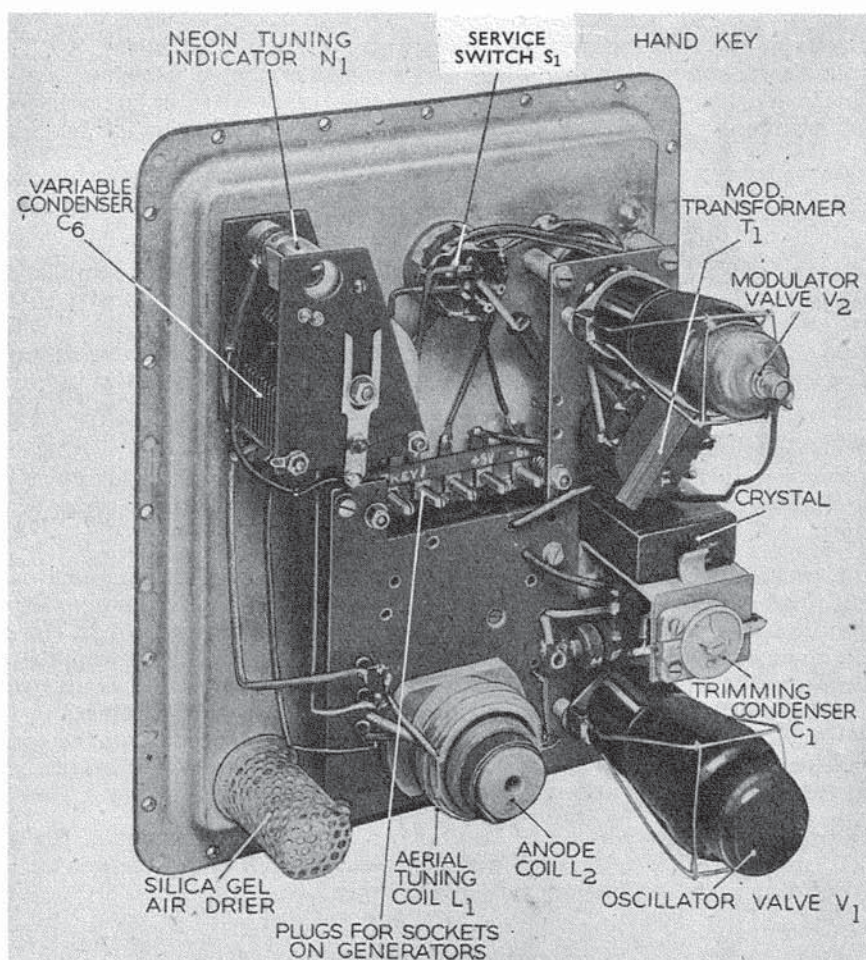


FIG. 4—REAR VIEW OF FRONT PANEL

28. At the top of the case is the generator driving handle which is secured in position in a dog by means of a screw having a left-hand thread. A locking ring is fitted over the generator spindle and normally this should be screwed down tightly to prevent the ingress of water. When the equipment is to be used, the locking ring should be unscrewed. When not in use, the driving handle of the generator is folded downwards and retained in position in the webbing pocket. A window is also fitted in the top of the case through which the tuning indicator lamp can be viewed.

29. The interior equipment of the case is assembled as two main units, (a) the back of the front panel assembly, and (b) the case assembly.

30. A view of the rear of the front panel is given in fig. 4 and it will be seen that on a bakelized fabric sub-panel are mounted the oscillator and modulator components in one assembly, the aerial tuning condenser and controls being mounted direct on the panel. The various components shown in the circuit diagram, fig. 3, are easily identifiable in this view.

31. The sub-panel carries a 5-pin plug assembly which, when the panel is fitted to the case, engages with a socket assembly on the power generator (see fig. 5).

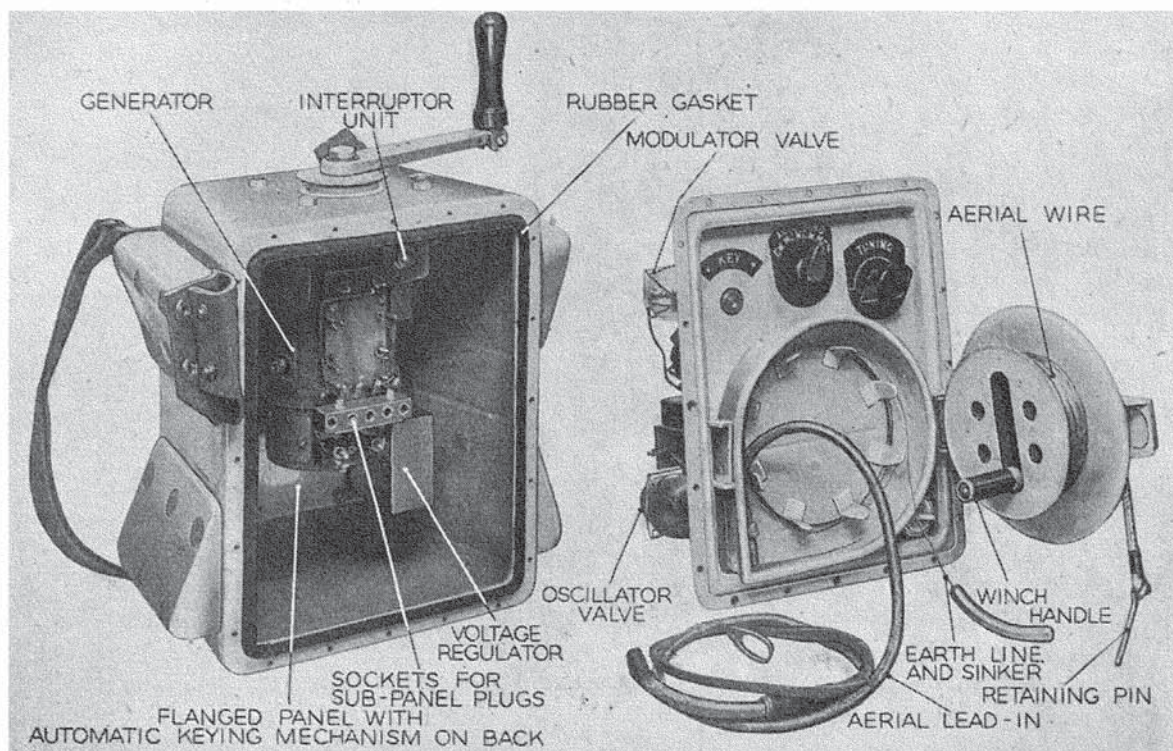


FIG. 5—VIEW SHOWING INTERIOR OF CASE

32. The power generator is fitted in the case and secured by seven screws; on the generator is a socket assembly which engages with the plugs of the front sub-panel assembly. The armature of the generator is driven by a train of four gear wheels which gives an overall ratio of 1 to 43.

33. A flanged steel panel is fitted in the back of the case and held in position by four screws. This panel is also secured to the back of the generator by means of a flexible piece of leather, the two units being fastened together before insertion in the case; should it be necessary to remove either, both must be taken out of the case as one assembly by taking out the case screws. On the front of the panel are mounted the interruptor and voltage regulator both of which are provided with covers. On the back is the selector unit; fig. 6 shows the assembly of these units on the panel. Explanations of their functions have been given in paras 14 to 21.

VALVES

34. Two valves, one indicator lamp and one crystal are employed in the equipment and particulars of these are given below:—

- V_1 , oscillator, type 6V6G
- V_2 , modulator, type 6J7G
- N_1 , neon tuning indicator
- X_1 , crystal, 500 kc/s,

Aerial balloon

35. The balloon for the support of the aerial is made of moulded latex rubber and is capable of being inflated to a diameter of 5 ft. without bursting. The normal inflated diameter, however, is a little over 3 ft. and this should not be much exceeded. The assembly of the balloon is given in

fig. 7, and it will be seen that fitted to the mouth of the balloon is a short length of rubber tube (1) and below this a bakelized paper tube (2) to which is attached the rubber filling tube (3). A short length of bakelized paper tube (4) is plugged into the end of the filling tube and this is fitted with a hollow rubber plug (5) for insertion in the gas generator. A loose stopper (6) attached to a

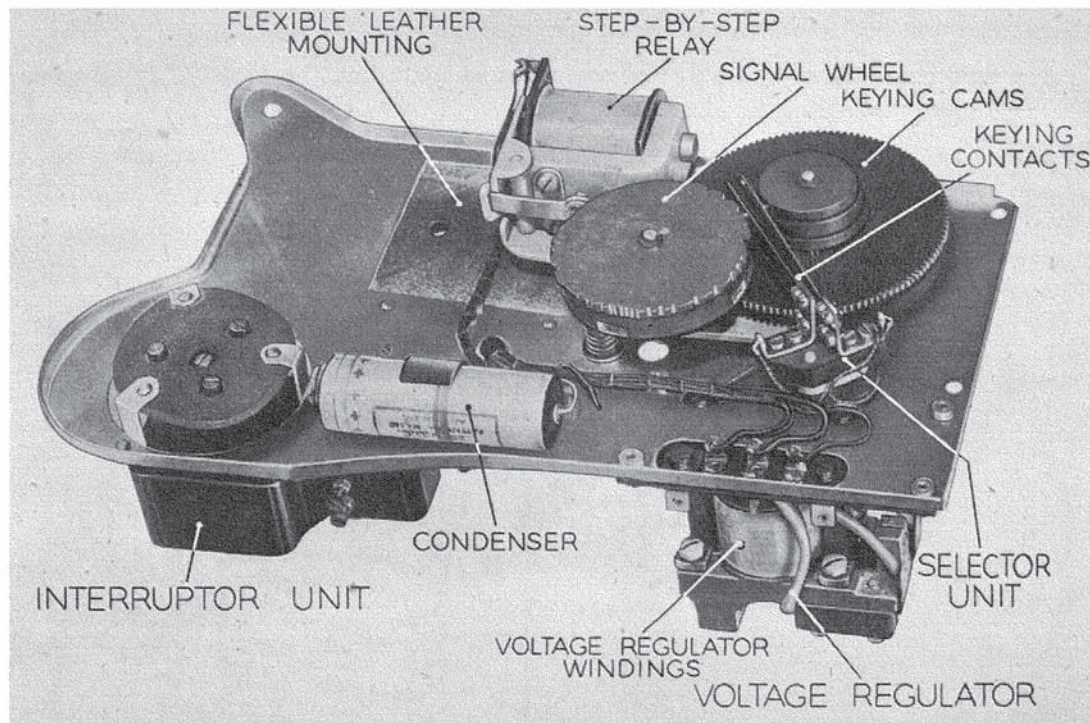


FIG. 6—AUTOMATIC KEYING MECHANISM AND VOLTAGE REGULATOR

length of cord is provided for insertion in the short length of the filling tube (1) after inflation is complete. Determination of the correct degree of inflation is obtained by measurement with a piece of cord (7) on which there are two knots (k) 30 in. apart. This measure (30 in.) is a quarter of the circumference of the balloon when inflated to the correct size.

36. When inflation is complete, the bakelized paper tube (2) is withdrawn from the rubber tube (1), the latter being pinched to prevent the escape of gas until the plug (6) is inserted.

Hydrogen generator

37. The hydrogen gas necessary for the inflation of the aerial balloon is generated by immersing a special cannister which is charged with calcium hydride in the water. It is immaterial whether the water is fresh or salt. The time required to inflate the balloon fully is approximately twenty minutes. A section of the generator is given in fig. 8. It consists of a tin-plate cannister $9\frac{1}{4}$ in. high and 4 in. in diameter fitted with a bottom which is recessed $1\frac{1}{2}$ in. A perforated metal tube approximately $\frac{3}{8}$ in. in diameter and 5 in. long is soldered to the bottom and stands centrally in the cannister. An inlet to this tube through the recessed bottom is provided and normally this inlet is sealed with a tear-off metal patch fitted with a D ring. A cap is fitted on the upper end of the perforated tube and on this rests a perforated metal diaphragm. Above this diaphragm, and supported by a distance piece is a series of baffle plates, the outlet from the last of these being just below the top of the canister. An internally flanged hole is provided in the top and normally this also is sealed with a tear-off patch.

38. The charge of calcium hydride is placed in the space surrounding the perforated metal tube and the whole assembly is sealed up. The hydrogen gas is generated by first removing the sealing patches from the top and bottom and then immersing the generator in water to a depth of approximately 7 in. Water enters the vertical perforated metal tube and comes into contact with the calcium hydride and hydrogen is given off. The gas after passing through the perforated metal plate and baffle spaces is collected by inserting a rubber tube fitted with a rubber plug in the outlet hole in the top. A handle of stout wire is fitted which can be bent upwards into a convenient position.

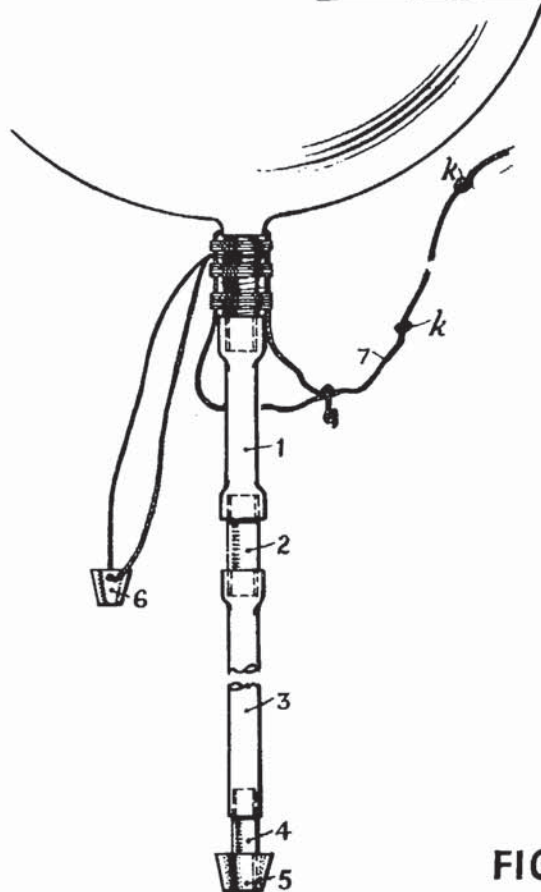


FIG.7:- DETAILS OF
BALLOON ASSEMBLY

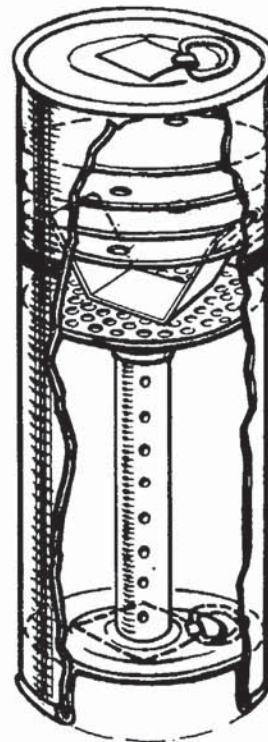


FIG.8:- SECTION OF
HYDROGEN GENERATOR

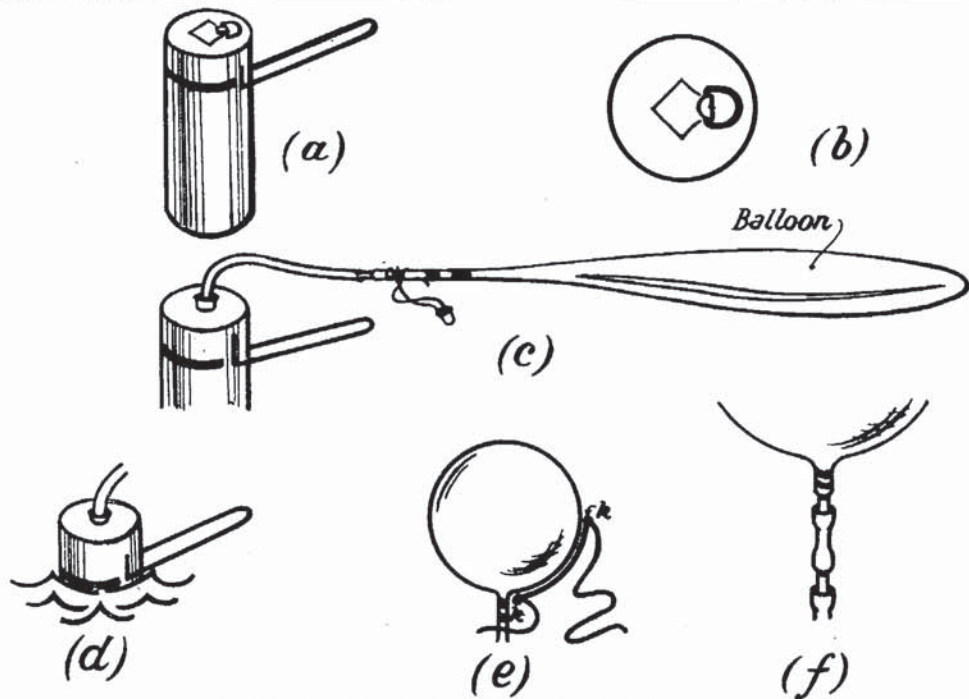


FIG.9:- DIAGRAMS SHOWING
INFLATION OF BALLOON

FIGS.7-9

FIGS.7-9

OPERATION

39. To set up the transmitter, it is first necessary to inflate the balloon and the following instructions relating both to this and the actual operation of the transmitter should be carried out in the order given.

Inflation of balloon

40. The successive stages in the inflation of the balloon are given in the diagrams (i) to (vi) of fig. 9, and the instructions relating to these are as follows:—

- (i) Bend up handle of generator to convenient position.
- (ii) Tear off sealing patches from both top and bottom of generator.
- (iii) Plug in balloon filling tube to top outlet of generator.
- (iv) Immerse generator in water to level of black line on generator until balloon is fully inflated. Shake occasionally but keep generator in water.
- (v) Inflation is complete when the distance between the two knots on the cord (one end of which is attached to the balloon) measures approximately one quarter the circumference of the balloon.
- (vi) Pinch the short length of rubber tube (1, fig. 7) on the balloon inlet. Remove inflator tube (3) and insert plug (6).

41. The time necessary for the inflation of the balloon is approximately twenty minutes and during the whole of this period it is important that the generator is not removed from the water.

Transmitter

42. The transmitter is prepared for operation in the following manner and sequence:—

- (i) Open aerial winch door by withdrawing the retaining pin (shearing the sealing wire in the end of the pin) and hook the end of the aerial on to the inflated balloon and release.
- (ii) Throw weighted earth line overboard.
- (iii) Slip leather thong of aerial lead-in round wrist (or fix to some convenient point) in order to relieve the strain when the aerial is connected.
- (iv) Pull handle out of recess in winch and unreel the aerial wire, controlling the speed by the brake located under the leather grip on the outside of the door. When fully unwound, unhook wire from the reel and attach it to the end of the screened aerial lead-in, taking care not to release hold on the aerial wire until the two are securely connected.
- (v) Set the handle for driving the generator by unclipping pocket, raising hand-grip to vertical position and unscrewing locking ring to the full extent.
- (vi) Set the service switch to the required transmitting position.
- (vii) Sling the webbing strap over one shoulder and *under* the arm to be used for turning the handle and grip the case between the knees with handle on top and control away from operator. Turn generator handle steadily for half-a-minute to warm up the filaments. The correct operating position is given in fig. 10.
- (viii) *Tuning*.—If only one operator is available, set the service switch to AUTO. (C.W. or M.C.W.) and tune for maximum brightness of the neon lamp which is visible through the window on the top of the case. If two operators are available, tuning will be simplified by setting the service switch to HAND (C.W. or M.C.W.) and while the one operator keeps the generator working, the other does the tuning and presses the hand key.

43. It should suffice to turn the generator handle for periods of 5 minutes every quarter of an hour at a speed of approximately 120 revolutions per minute. Care should be taken to avoid contact with the uninsulated portion of the aerial wire while the transmitter is being operated.

44. When it is required to close the transmitter down, the aerial wire should be unhooked from the lead-in and attached to the small hook on the reel. The earth line and aerial lead-in are wound round the lugs in the panel compartment and the aerial wound up and detached from the balloon, after which the aerial case is closed and secured with the retaining pin which is resealed with the spare wire provided. Finally the generator handle grip should be folded down and the locking ring under the handle screwed down to make the case watertight.

PRECAUTIONS AND MAINTENANCE

45. As this type of transmitter is only likely to have limited use, the amount of maintenance work necessary should be small, but routine checks must be made as described later. Although the case is watertight, it is not airtight and with varying atmospheric pressures at different altitudes there is the possibility of the ingress of water vapour. Limited amounts of moisture will be absorbed by the silica-gel unit but it will be necessary to dry or replace the element at suitable intervals, the length of which will depend on the conditions of use of the instrument and climatic conditions.

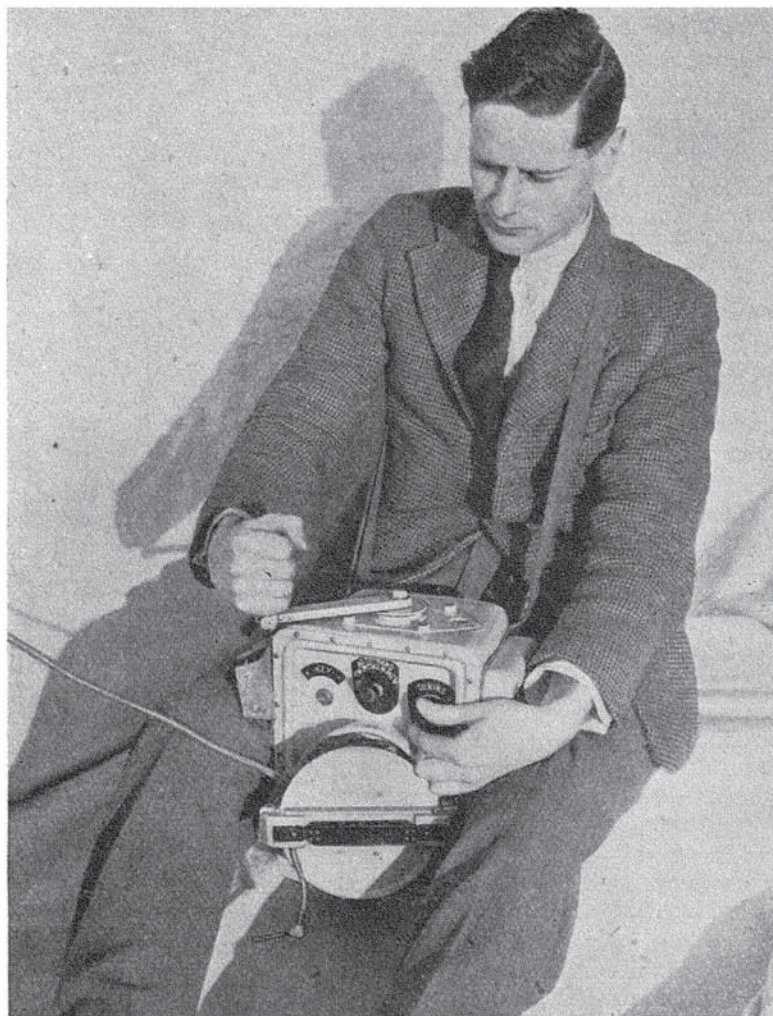


FIG. 10—VIEW SHOWING CORRECT METHOD OF OPERATION

46. Tuning is liable to vary with variations from the perpendicular of the aerial in strong winds owing to alteration of capacity; repeated checks of the maximum brightness of the indicator lamp should therefore be made while the equipment is in operation.

47. When the speed of the wind exceeds about 15 miles per hour, there may be difficulty in maintaining the aerial in a position many degrees above the horizontal, because of the small lifting power of the balloon. Under these conditions there is the possibility of the aerial dipping into the sea, when of course transmission would greatly diminish or cease entirely. It may, therefore, be impossible to use this apparatus with existing aerial arrangements in a high wind. Development work, however, is proceeding on the production of a kite balloon and a projectable kite but both present many difficulties of a technical nature. In the event of either or both of these being found practicable, arrangements will be made for supply. A ball of twine, 200 ft. long, is provided with each equipment so that the balloon will act as a visual signal should there be any difficulty in operating the transmitter.

Operational check

48. The correct operation of the equipment should be checked before each operational flight. This is done by measuring the power output obtained into the external artificial aerial load. This aerial load should consist of a capacity of 360 to 500 $\mu\mu\text{F}$. in series with a 30-ohm resistance, the outer end of the latter being earthed. The most suitable value for the capacity is 430 $\mu\mu\text{F}$. plus or minus 16 per cent. and it can be obtained either by using a variable condenser or a suitable arrangement of fixed condensers. An artificial aerial (Stores Ref. 10B/13281) is available. The checking procedure is as follows:—

- (i) Open winch door.
- (ii) Connect end of aerial lead-in to aerial terminal of load.
- (iii) Connect earth lead to earth terminal of load.
- (iv) Set generator handle by unclipping pocket, raising hand piece and unscrewing locking ring, fully counter-clockwise.
- (v) Set service switch to HAND M.C.W.
- (vi) Turn handle steadily for half-a-minute at 120 r.p.m. to warm up filaments.
- (vii) Press hand key and tune by turning tuning knob until neon lamp gives maximum glow, or until the aerial load ammeter (if used) gives maximum reading. This should be approximately 0.4 amp.
- (viii) Repeat (vii) above on HAND C.W. (key pressed).
- (ix) Repeat on AUTO. M.C.W. and note sequence of signals by observing flashing of neon lamp (or fluctuations of aerial ammeter).
- (x) Repeat on AUTO. C.W. The correct sequence of signals on AUTO is twelve long dashes followed by three S.O.S. signals. One long dash signal should be approximately four seconds duration followed by a one-second interval. The time for ten such signals should be between limits of 45 and 55 seconds.
- (xi) When satisfied that the equipment operates correctly, the earth wire must first be wound carefully into the front panel recess round the lugs provided, followed by the lead-in. The winch door should then be closed and the securing pin reinserted and sealed with a short length of the wire provided for this purpose (25 s.w.g. tinned copper).

Fault location

49. In the event of the equipment not operating satisfactorily it may be due to corrosion or the ingress of water and a general internal inspection should be made by removing the front panel. This can be done by removing the twenty 4 B.A. screws round its edge and gently easing it away from the case, thus breaking the seal formed by the rubber gasket and Bostik solution. The panel should be drawn off carefully, avoiding damage to the inter-unit pins, valves, etc. Any parts which show corrosion or leakage should be treated according to the nature of the damage. In general, the following points should particularly be checked.

- (i) *Aerial lead-in elbow.*—If signs of leakage at this point are present, the retaining nut should be slackened and the tapered surfaces of the elbow resealed with bakelite varnish. The nut should then be retightened carefully.
- (ii) *Service switch and tuning spindle glands.*—Remove knob and gland nuts. The felt rings inside the gland nuts can be repacked with anti-freeze grease or replaced if damaged. The surfaces of the nuts in contact with the front panel should be smeared with bakelite varnish before re-assembly.
- (iii) *Hand key.*—If there are leaks at this point, the rubber diaphragm should be inspected and replaced if damaged. The diaphragm should be lightly smeared with Bostik. The centre nut must not be over tightened so as to cause the gasket to be squeezed out from under the washer and the eight 8 B.A. nuts must be tightened evenly, a little at a time. The key action must be definite and clean and not indeterminate and spongy.
- (iv) *Neon windows.*—If there are leaks at the neon window, the rubber gasket should be replaced, the surfaces being lightly smeared with Bostik and the nuts tightened evenly.
- (v) *Generator handle gland.*—To obtain access to the driving handle gland, unscrew the locking ring fully counter-clockwise and remove the handle by unscrewing the hexagon-headed screw at the centre. This screw has a left-hand thread and therefore must be unscrewed clockwise. It can be undone by quick movements of the spanner against the inertia of the generator armature. Attempts to prevent the armature rotating should not be made. The packing gland is in the annular recess around the spindle. The packing should be removed and replaced with a new one after carefully cleaning the recess. When reassembling the handle, ensure that the driving tongue engages correctly with the slot in the generator shaft and turn counter-clockwise to check that the ratchet is operating.

- (vi) *To remove generator and sub-panel.*—The generator and sub-panel must be removed together in the following sequence: Remove generator handle as described in (v); remove Ozokerite wax and undo seven screws at the handle end of case; remove four panel retaining screws (inside case) after which the generator and panel may be carefully eased out, taking care not to damage the mechanism under the panel by contact with the mounting pillars.

50. When the generator is out of the case, access to the commutators and brush gear can be obtained by removing the four inspection covers. Inspect for chipped or cracked brushes and if in order replace in original positions. The commutators may be cleaned with a soft rag and carbon tetrachloride. Emery cloth must on no account be used, but if scoring has taken place they may be lightly cleaned with the finest sand paper. Examination of the gear box should be made by removal of the cover plate. If water has penetrated, the old grease should be removed, and the box repacked. Care must be taken when reassembling the generator in the case not to omit the four distance pieces and the felt washer between the case and generator. The felt washer must be soaked in molten anti-freeze grease before being fitted and melted Ozokerite wax should be run in over the heads of the seven holding screws.

Voltage regulator adjustment

51. The adjustment of the voltage regulator of the generator should not be altered unless necessary. Should it have been disturbed, it should be re-adjusted as follows: Energize the coil with 8 volts D.C. across terminals 1 and 3 (fig. 12). Adjust contact gap to 0.012 in. and tighten the lock nut, using the test circuit fig. 12, with terminals 1 and 2 short circuited; adjust voltage across terminals 2 and 3 to 6.7 volts. Then adjust back-stop so that voltage drop across terminals 1 and 3 is less than 6.7 volts and more than 6.3. Finally, lock all adjusting screws and coat them with bake-lite varnish.

Interruptor unit adjustment

52. Owing to the delicate nature of the interruptor unit it should not be dismantled, but the following checks can be made and the adjustment corrected as necessary. The rotor should oscillate freely and not have more than 0.0015 in. end play (equal to one eighth turn of bearing screw). The contacts should be in alignment and rest on their back springs with a light pressure. At normal, the rotor teeth should be out of alignment with keepers in a clockwise direction, so that corners overlap by 0.010 in. to 0.030 in., upper contacts to be broken and lower contact pressure to be not less than 5 grammes measured at edge of contact bracket on rotor. With interruptor in any position and $5\frac{1}{2}$ to 7 volts D.C. applied (with a 25 μ F. condenser connected across contacts), the impulse rate should be $4\frac{1}{2}$ to $5\frac{1}{2}$ per sec. The rate of oscillation can be adjusted by rotating the hair spring bracket. It is essential that the convolutions of the spring are quite free, and this can be accomplished by loosening the screws securing the bracket and moving it laterally.

Selector adjustment

53. For the correct operation of the selector unit, the following conditions should obtain. The cam assemblies must be individually free on their respective spindles. Gear wheel and pinion should mesh freely with the minimum amount of backlash. The retaining pawl should be two to three teeth behind the driving pawl. It should rest lightly at the base of the tooth and there should be a minimum backward movement of the cam when the armature restores. The armature back stop should be set to allow the driving pawl to drop back over one tooth during release; the maximum permissible back movement is $1\frac{1}{2}$ teeth. Contact springs should be adjusted so that the contacts are in alignment when touching, with the springs approximately at right angles to the block.

Electrical faults

54. Two fault-finding charts are given in fig. 11. The tests outlined in these should preferably be made with batteries by removing the front panel of the transmitter (*see* para. 49) and connecting 320 volts to H.T. and 6 volts to L.T. pins. If batteries are not available, checks can be made on the hand generator, but the front panel should be removed and the 5-pin plugs and sockets connected up with extension leads; this permits of easy access to the components. In order to ensure steady readings on the meter the generator handle should be turned at approximately 130 r.p.m. so that the voltage regulator will be operating.

55. The grid current readings of V_1 should be taken by disconnecting the lead to I.S. of transformer T_1 and inserting the milliammeters between I.S. and this lead. Grid current readings of V_2 are taken by disconnecting the lead to the earthy end of resistance R_5 and inserting the meter between R_5 and L.T.—

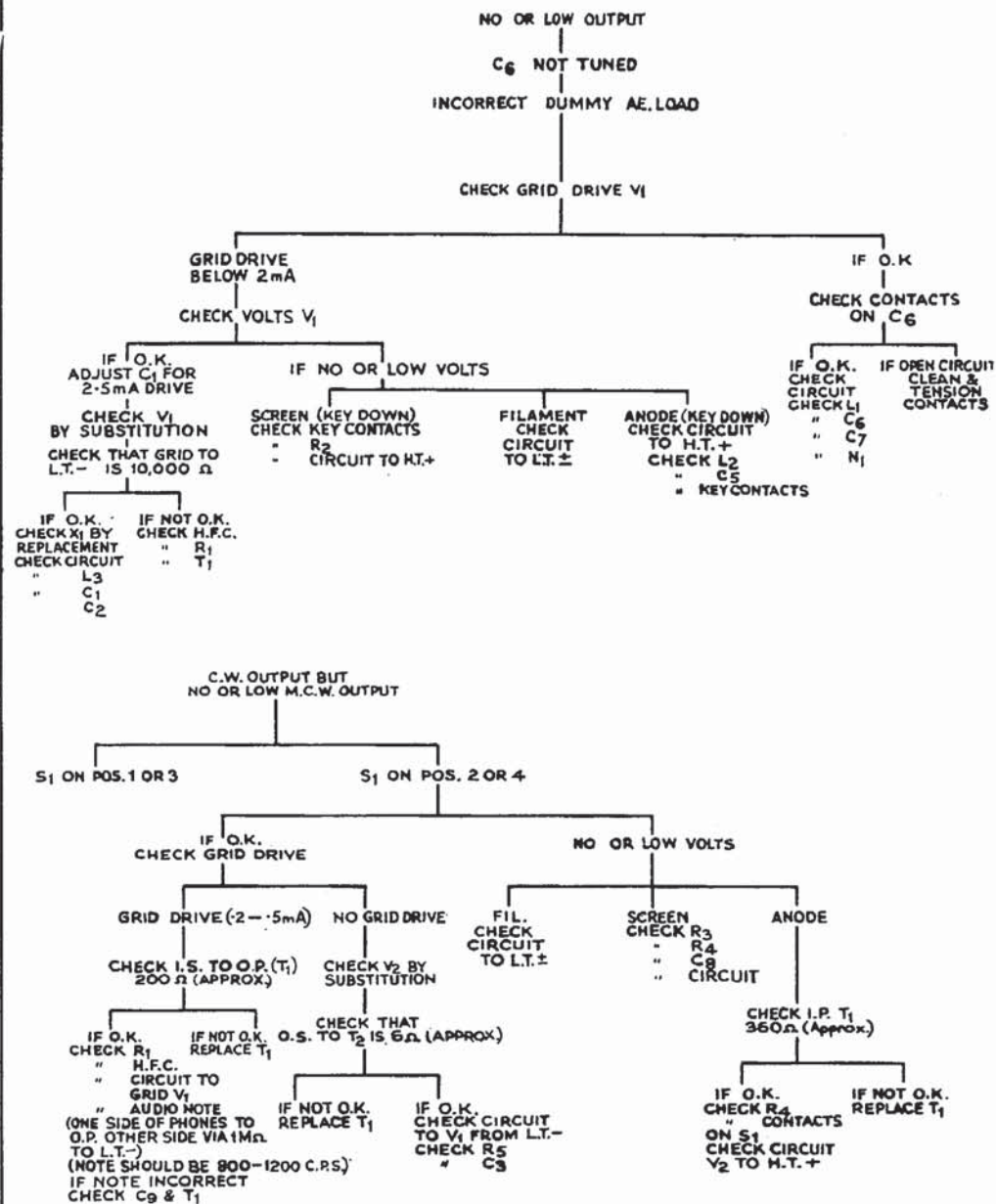


FIG.11

FAULT LOCATION CHARTS

FIG.11

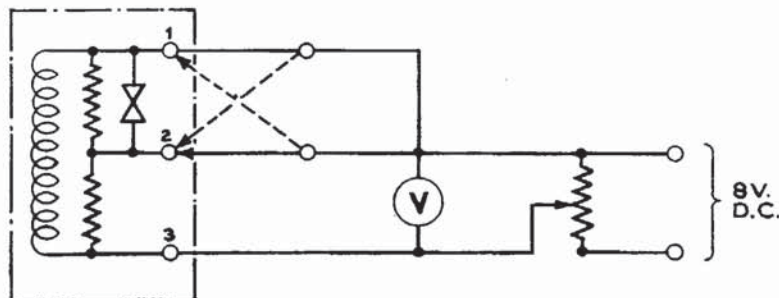


FIG.12

VOLTAGE REGULATOR TEST CIRCUIT

FIG.12

56. A test of the operation of the auto-key unit is made by connecting together terminals L.T.— and KEY 2 of 5-pin socket and turning the generator handle.

Silica-gel desiccator

57. The silica-gel desiccator must be regenerated or replaced after (a) six months, (b) breaking the air-tight condition of the equipment (e.g. after internal inspection or repair) and (c) immersion of the equipment in water.

58. The desiccator is regenerated by removing the screw cap of the container and withdrawing the bag which is then heated in an oven for a period of one to two hours at a temperature that will not char the bag (approx. 250 deg. F.). The bag should then be replaced in its case immediately, care being taken to see that the leather washer is in position and the cap screwed on tightly. This drying-out process can be repeated indefinitely, but the bag must not be left exposed to the air before insertion in its container.

59. After operational use which has resulted in the immersion of the equipment in water it should be examined for external damage and signs of leakage. The silica-gel desiccator should be examined and if it is excessively damp, the front panel should be removed and the interior equipment examined after which the routine checks described in para. 48, should be made.

60. Before the front panel is replaced, the old sealing compound should be cleaned off the case, panel and gasket with benzine and new solution applied. Care must be taken to engage the inter-plug and socket correctly, after which the screws can be inserted and tightened down a little at a time, so that the pressure will be evenly distributed. The two countersunk holes and screw heads must be clean in order to ensure a good earth connection.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig.	Remarks
10R/13002	Transmitter, type 1333	1		Emergency transmitter for use in dinghy
	Principal components:—			
	Choke			
10C/79	Type	1		H.F., 1.5 mH
	Coil, aerial tuning			
10R/13003	Type	1		Pile wound, 58 turns, Litz wire
	Coil, anode coupling			
10R/13004	Type	1		Wire wound, 112 turns
	Coil tuning			
10R/13005	Type	1		Iron dust core, 89 turns
	Condenser			
10C/5028	Type 2698	1	C ₁	20–120 μ F, ceramic
10C/4999	Type 2689	1	C ₂	250 μ F, 1,000 volts
10C/3190	Type 1545	1	C ₃	0.1 μ F, 450 volts
10C/8496	Type 188	1	C ₄	0.01 μ F, 350 volts
10C/3055	Type 1465	1	C ₅	0.01 μ F, 500 volts
10C/4979	Type 2669	1	C ₆	Variable with switch and glands
10C/5020	Type 2690	1	C ₇	4 μ F, 500 volts
10C/8190	Type 1545	1	C ₈	0.1 μ F, 450 volts
10C/8496	Type 188	1	C ₉	0.01 μ F, 350 volts
10C/4980	Type	1	C ₁₀	25 μ F, 25 volts
	Type	1	C ₁₁	0.2 μ F.
	Crystal			
10X/500	Type	1	X1	500 kc/s.
	Drying charge			
10D/3087	Type 1	1		Silica-gel in linen bag
	Holder, valve			
10H/493	Type 73	2		
	Lamp, indicating			
10E/484	Type 671	1	N1	Neon
	Resistance			
10C/7017	Type 7017	1	R ₁	10,000 ohms, $\frac{1}{2}$ -watt
10C/1274	Type 1274	1	R ₂	10,000 ohms, 1 watt
10C/7181	Type 7181	1	R ₃	5,000 ohms, $\frac{1}{2}$ watt
10C/6221	Type 6221	1	R ₄	50,000 ohms, 1 watt
10C/6005	Type 6005	1	R ₅	50,000 ohms, $\frac{1}{2}$ watt
	Valve			
10E/349	Type 6V6G	1	V ₁	American octal
10E/352	Type 6J7G	1	V ₂	American octal
	Wire aerial			
	Type			
10B/13281	Artificial aerial	1		
	Type 18			

SECTION 1, CHAPTER 13

TRANSMITTER T.1333

(Stores Ref. 10D/1422)

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INTRODUCTION

1. The purpose of the transmitting equipment described in this chapter is to enable one-way emergency communication to be made from a dinghy, boat, or other situation, with ships and shore stations. It is capable of transmitting morse S.O.S. signals automatically and continuously, or the transmitter can be keyed and any necessary message be transmitted. With automatic transmission, the S.O.S. signal (distress) is repeated three times and these are then followed by twelve long dashes, the sequence being continued so long as the transmitter is in operation. The equipment has primarily been designed to be operated from a rubber dinghy under emergency conditions and on this account it possesses several special features which are described in detail later. The spot frequency is 500 kc/s (600 metres) crystal control and the transmitter provides either C.W. or M.C.W. service. The power output into the aerial is 5 watts and under the most suitable conditions the range is approximately 100 miles.

A (AL 55)



FIG. 1—VIEW OF EQUIPMENT IN DINGHY

2. The equipment consists of two separate units as detailed below:—
 - (i) Transmitter, including a hand-driven generator for all power supply, aerial wire and earth line.
 - (ii) Rocket kite apparatus for launching a kite into the air for support of the aerial.
3. A view showing the equipment in use is given in fig. 1. The transmitter is supported between the knees of the operator, and the aerial raised by the kite and the earth line dropped into the water. After the transmitter is tuned, S.O.S. signals are sent out automatically by merely turning the handle of the power supply generator. Operation is therefore possible by one person, but it is facilitated by a second, particularly if it is required to transmit a message by keying.
4. The transmitter is watertight and will float. It can be dropped into the sea from a height of ten feet without injury and as it is contained in a yellow waterproof cover it is easily discernible when in the water. It will not adversely be affected by altitudes up to 40,000 ft., by any temperature between $+30$ deg. C. and -20 deg. C or by vibration of 10G in any plane at frequencies between 25 and 100 c/s. The weight of the complete transmitter, including 208 ft. of aerial wire and earth line and sinker is approximately 22 lb. This weight does not, however, include the rocket kite apparatus.

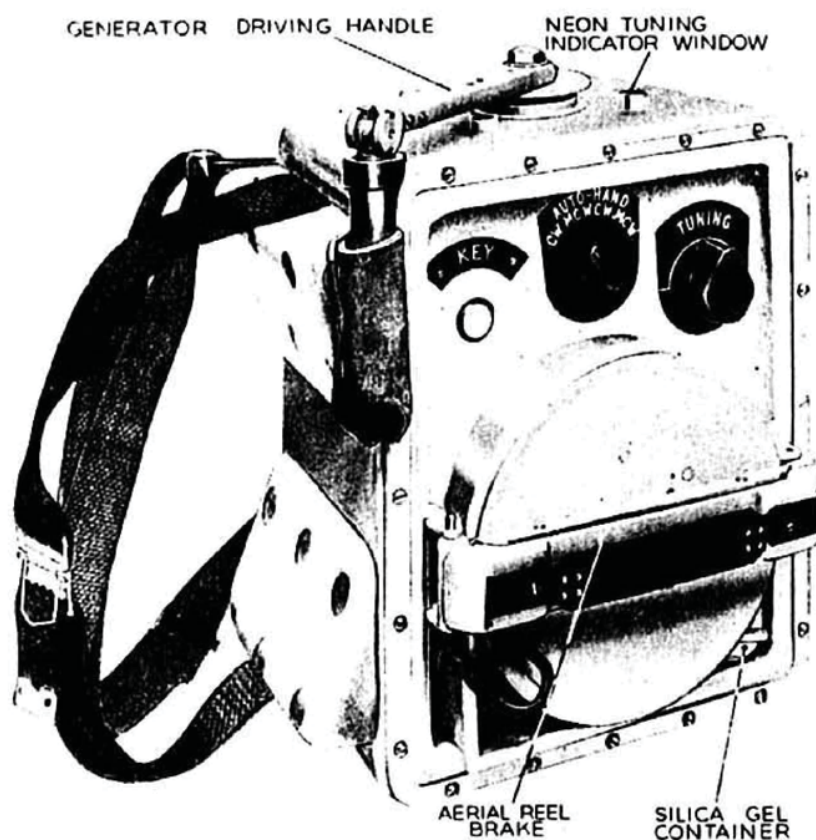


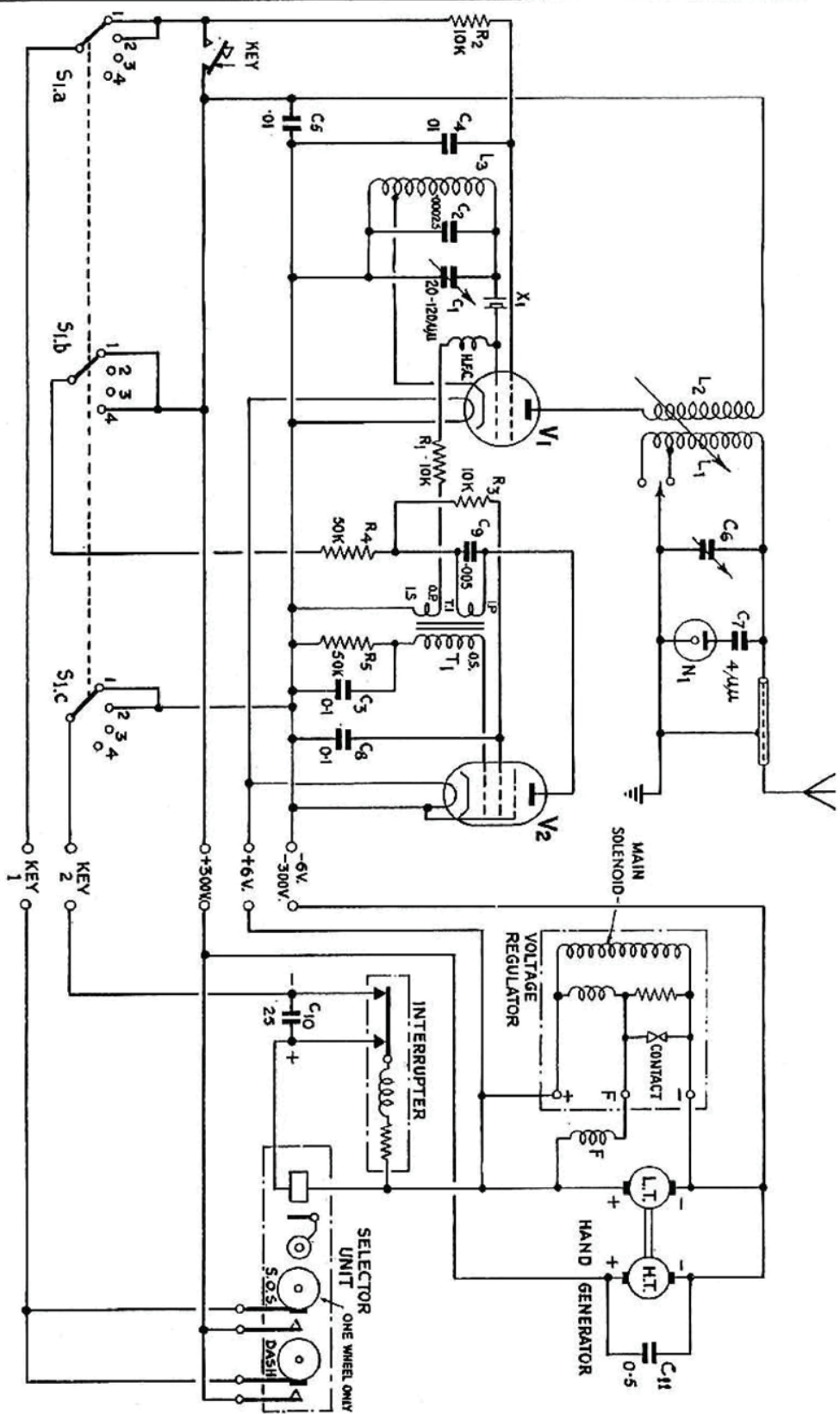
FIG. 2—VIEW OF TRANSMITTER T.1333

GENERAL DESCRIPTION

Transmitter

5. The view of the complete transmitter is given in fig. 2. It consists of a light steel case which contains the oscillator and modulator, the hand-driven generator for providing the L.T. and H.T. supplies, the voltage regulator, the interruptor, the selector and aerial and earth line. These units are described in detail later.

6. The circuit of the transmitter and power unit is given in fig. 3 and it will be seen that a beam power valve (type 6V6G) V_1 , is used as an electron-coupled crystal-controlled oscillator. The screen grid and cathode of this valve form the elements of an inverted Hartley oscillator with a crystal X_1 inserted in the grid circuit, thus forming a crystal locked circuit. Keying is accomplished by breaking the screen supply to the oscillator.



T.1333
CIRCUIT

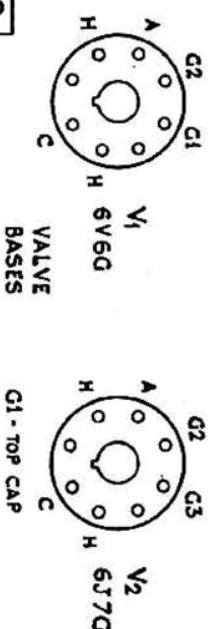


FIG. 3

FIG. 3

7. For use on M.C.W. an A.F. pentode modulator valve (type 6J7G) V_2 , is employed with a transformer T_1 to provide feed back between anode and grid circuits. The primary of the transformer is capacity tuned to give a modulating tone of approximately 1,000 c/s. This is fed to the output stage valve V_1 , via the grid leak R_1 and R.F. choke (H.F.C.), by means of a tertiary winding on the transformer. The modulator valve V_2 is not keyed and oscillates continuously when in circuit.

8. The aerial coil is capacity tuned and is provided with two taps which are selected by means of a switch which is integral with the tuning condenser spindle, the effect being approximately to double the tuning range of the variable condenser C_4 .

9. The aerial is connected to one end of the coil, the earth lead being connected to the other end.

10. Tuning indication is provided by a neon lamp N , which is connected in series with a small condenser C_7 across the aerial coil, maximum output being indicated at maximum lamp brilliance.

Power unit

11. The circuit of the hand-driven generator with its associated voltage regulator is also included in fig. 3. Included in this diagram are the circuits of the interruptor and selector units which are described later. Two outputs (330 volts H.T. and 6.3 volts L.T.) are provided by the generator, these being collected by the two pairs of brushes.

Voltage regulator

12. The voltage regulator consists of a relay having an iron-cored bobbin carrying two inductive windings and one non-inductive winding. An armature, mounted on a stiff reed is tuned to a periodicity of approximately 1,000 c/s and carries a contact which, in the non-operated state, makes with a stationary self-centring contact. As the voltage rises across the L.T. brushes of the generator, the flux density of the relay core increases, attracts the armature and breaks the contacts, thus putting the 42-ohm resistance-winding of the relay in series with the field winding F of the generator. Less current then flows in the field windings of the generator and this reduces the voltage across the L.T. brushes, with the result that the contacts make again. This cycle is repeated at the natural frequency of the armature of the relay. It will be clear that the lowered L.T. voltage will reduce the flux of the relay magnet owing to the smaller current flowing in the 55-ohm shunt winding. Since the regulator controls the common field winding of the generator, it governs both the L.T. and H.T. voltages and it can be adjusted to operate at a predetermined L.T. voltage.

Automatic keying mechanism

13. The automatic keying mechanism is for the purpose of automatically transmitting sequences of three S.O.S. signals followed by twelve long dashes. It consists of (a) a selector unit and (b) an interruptor which operates the selector unit.

Selector unit

14. The circuits of the selector unit and interruptor are included in fig. 3. The selector unit consists of a simple electro-magnetic relay which steps round a ratchet wheel. This in turn drives a wheel, the periphery of which is provided with two series of notches or grooves to produce three S.O.S. signals and four long dashes. This wheel is shown in two sections in the circuit diagram.

15. Two pairs of keying contacts, one operated by the S.O.S. and the other by the long dash grooves on the signal wheel are connected in parallel and break the H.T. feed to the R.F. oscillator valve screen.

16. The sequence of three S.O.S. signals and twelve long dashes is accomplished by means of two cams on a large toothed wheel geared to the signal wheel in the ratio of 1 to 4. These cams are so designed that for a quarter revolution of the large toothed wheel, the S.O.S. contacts will come into operation, the long dash contacts being inoperative, while for the remaining three-quarters of a revolution the long dash contacts operate, the S.O.S. contacts now being inoperative.

Interruptor unit

17. The interruptor unit governs the periodicity of the impulses fed to the selector unit, irrespective of the supply voltage fluctuations. Its purpose therefore is to supply a series of timed impulses to drive the selector unit.

18. The unit consists of a small spring-controlled bobbin-shaped armature carrying a small coil wound at right angles to its axis and surrounded by a stator. This stator consists of eight short lengths of soft iron disposed circularly and held in place by being embedded in the material of the case containing the device. When the keying switch is set to AUTO, L.T. is applied to the armature

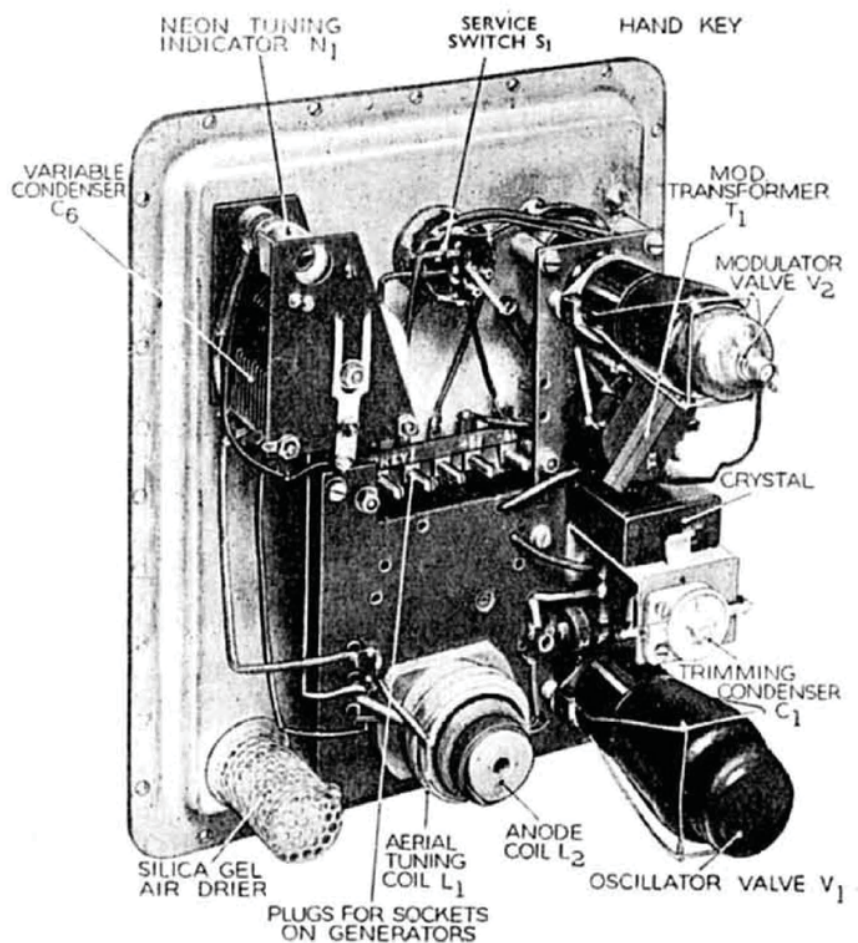


FIG. 4—REAR VIEW OF FRONT PANEL

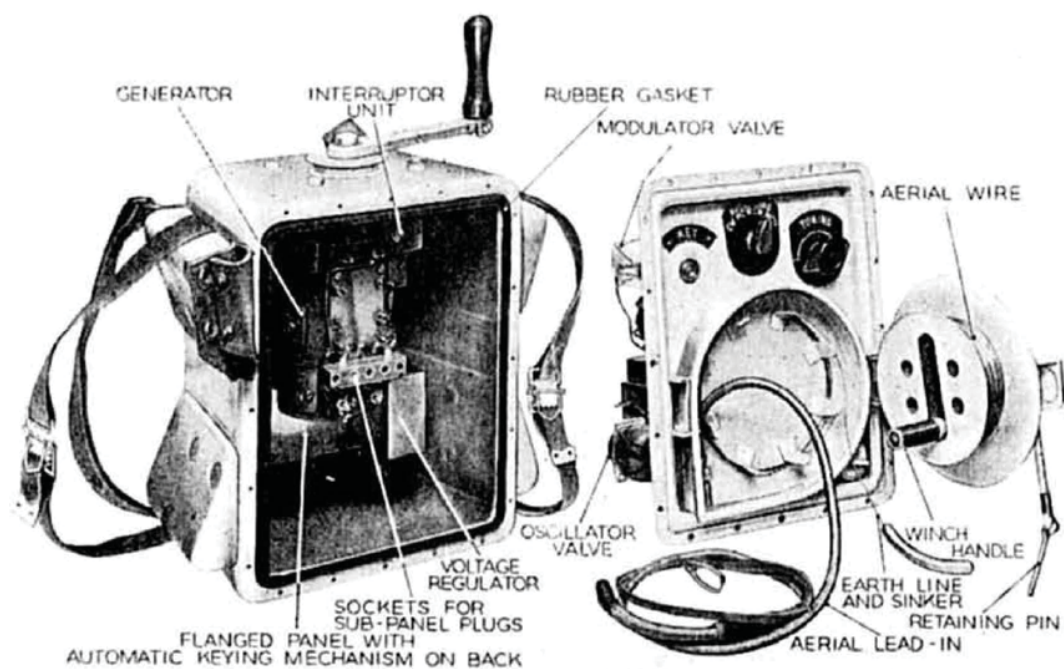


FIG. 5—VIEW SHOWING INTERIOR OF CASE

coil, causing its ends to become oppositely polarised, whereupon the coil swings towards the soft iron pole pieces. This partial rotation of the armature breaks a pair of contacts in the L.T. supply when, due to the torsion of a spiral hair spring, the armature swings back and the contacts are again made, and the cycle repeated; this operation, which is similar to the oscillation of the balance wheel of a watch, is repeated at a rate of approximately 5 c/s.

19. Another pair of contacts which are also operated by the movement of the armature, make and break the L.T. supply to the relay of the selector unit which thus receives an impulse to step the signal wheel round at each oscillation cycle of the armature.

CONSTRUCTION

20. The transmitting equipment, which includes the transmitter, power unit, voltage regulator, automatic keying mechanism, aerial and earth line, is contained in a light steel case, the sides and bottom of which are strengthened by ribbing.

21. Knee grips are provided on the two sides of the case which is also fitted with a webbing strap for slinging over the shoulder of the operator and two knee straps.

22. The front panel, which is also a light steel pressing, is secured to the body of the case by twenty screws and a gasket is fitted between the edges of the case and the panel. The case is water-tight, felt glands impregnated with oil being fitted at all spindle entries and blind holes being employed for all screws. A silica-gel drying unit is fitted which will absorb a limited amount of moisture which may get into the case by condensation from the atmosphere. It will not, however, cope with actual leakage of sea water.

23. On the front panel are the hand key, a service switch with four positions and aerial tuning knob, each being easily identifiable by a name plate with lettering in luminous paint which is radio-active and does not require previous exposure to light to become luminescent.

24. On the lower part of the front panel is an annular case with a hinged door containing the aerial reel. A series of projections are provided in the case round which are wound the aerial lead-in and earth line. The aerial consists of 208 ft. of stainless steel flexible wire, and the earth line, which is 10 ft. long, is provided with a sinker. A spring-loaded folding handle is fitted to the aerial reel and a brake button is fitted under the leather handle on the outside of the door. The door is secured when closed, by a pin attached to the case by a leather thong. This pin is retained in position by a thin piece of soft wire threaded through a hole in the end and this can be sheared by the action of withdrawing the pin.

25. At the bottom right-hand corner of the front panel is the silica-gel drying unit which is provided with a cap, and by the removal of this, access can be had to the drying element for renewal or revitalisation.

26. At the top of the case is the generator driving handle which is secured in position in a dog by means of a screw having a left-hand thread. A locking ring is fitted over the generator spindle and normally this should be screwed down tightly to prevent the ingress of water. When the equipment is to be used, the locking ring should be unscrewed. When not in use, the driving handle of the generator is folded downwards and retained in position in the webbing pocket. A window is also fitted in the top of the case through which the tuning indicator lamp can be viewed.

27. The interior equipment of the case is assembled as two main units, (a) the back of the front panel assembly, and (b) the case assembly.

28. A view of the rear of the front panel is given in fig. 4 and it will be seen that on a bakelized fabric sub-panel are mounted the oscillator and modulator components in one assembly, the aerial tuning condenser and controls being mounted direct on the panel. The various components shown in the circuit diagram, fig. 3, are easily identifiable in this view.

29. The sub-panel carries a 5-pin assembly which, when the panel is fitted to the case, engages with a socket assembly on the power generator (see fig. 5).

30. The power generator is fitted in the case and secured by seven screws; on the generator is a socket assembly which engages with the plugs of the front sub-panel assembly. The armature of the generator is driven by a train of four gear wheels which gives an overall ratio of 1 to 43.

31. A flanged steel panel is fitted in the back of the case and held in position by four screws. This panel is also secured to the back of the generator by means of a flexible piece of leather, the two units being fastened together before insertion in the case; should it be necessary to remove either, both must be taken out of the case as one assembly by taking out the case screws. On the front of the panel are mounted the interruptor and voltage regulator both of which are provided with covers. On the back is the selector unit; fig. 6 shows the assembly of these units on the panel. Explanations of their functions have been given in paras. 12 to 19.

32. Two types of case are used for transmitter T.1333. One type is the same as is shown in the general photographs and this has knee grips of moulded rubber or cork attached to the sides of the case by countersunk screws, the metal sides being flat as can be clearly seen in fig. 5.

33. With the other type of case the knee grips are pressed out of the metal and the only attachments are the shoulder and knee straps. In all other respects the transmitters are alike and the parts of one, including the front panel, generator and driving handle, are interchangeable. The actual transmitter therefore can be installed in either type of case without any modification.

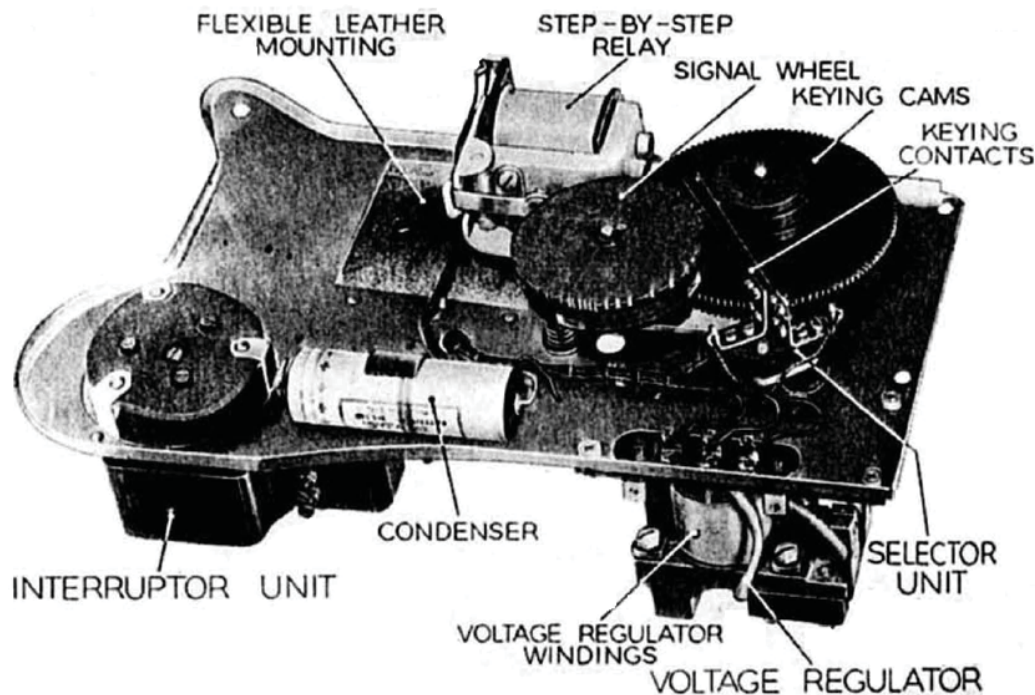


FIG. 6—AUTOMATIC KEYING MECHANISM AND VOLTAGE REGULATOR

VALVES

34. Two valves, one indicator lamp and one crystal are employed in the equipment and particulars of these are given below:—

V₁, oscillator, type 6V6G

N₁, neon tuning indicator

V₂, modulator, type 6J7G or KTZ63

X₁, crystal, 500 kc/s.

Waterproof packing

35. Although special precautions have been taken to make the case of the transmitter watertight, it has been found necessary to enclose it in a double case consisting of felt and waterproof material, the latter being fitted with a breather valve. This valve will allow of variations of atmospheric pressure at different altitudes, but it seals automatically when it becomes wet. It consists of a spongy substance contained in a wooden cylinder used to close the mouth of the waterproof case; this substance expands when wet and provides an effectual seal against the ingress of water.

36. The method of packing the transmitter in the two cases is important and is shown by the series of diagrams given by fig. 7 which are explained in a series of stages below. The references are the same as those on the diagrams.

- (i) Place transmitter in the felt bag as shown at (1) with the generator handle underneath and the control panel towards the operator.
- (ii) Fold front flap of felt bag over the transmitter, then fold the two side flaps over and finally the long flap. Lay the tapes underneath, then pass them over and tie on top with quick release double bow knots.
- (iii) Place transmitter (now in felt case) in the waterproof case keeping it in the position shown, i.e., generator handle underneath and long flap of felt case away from operator. The

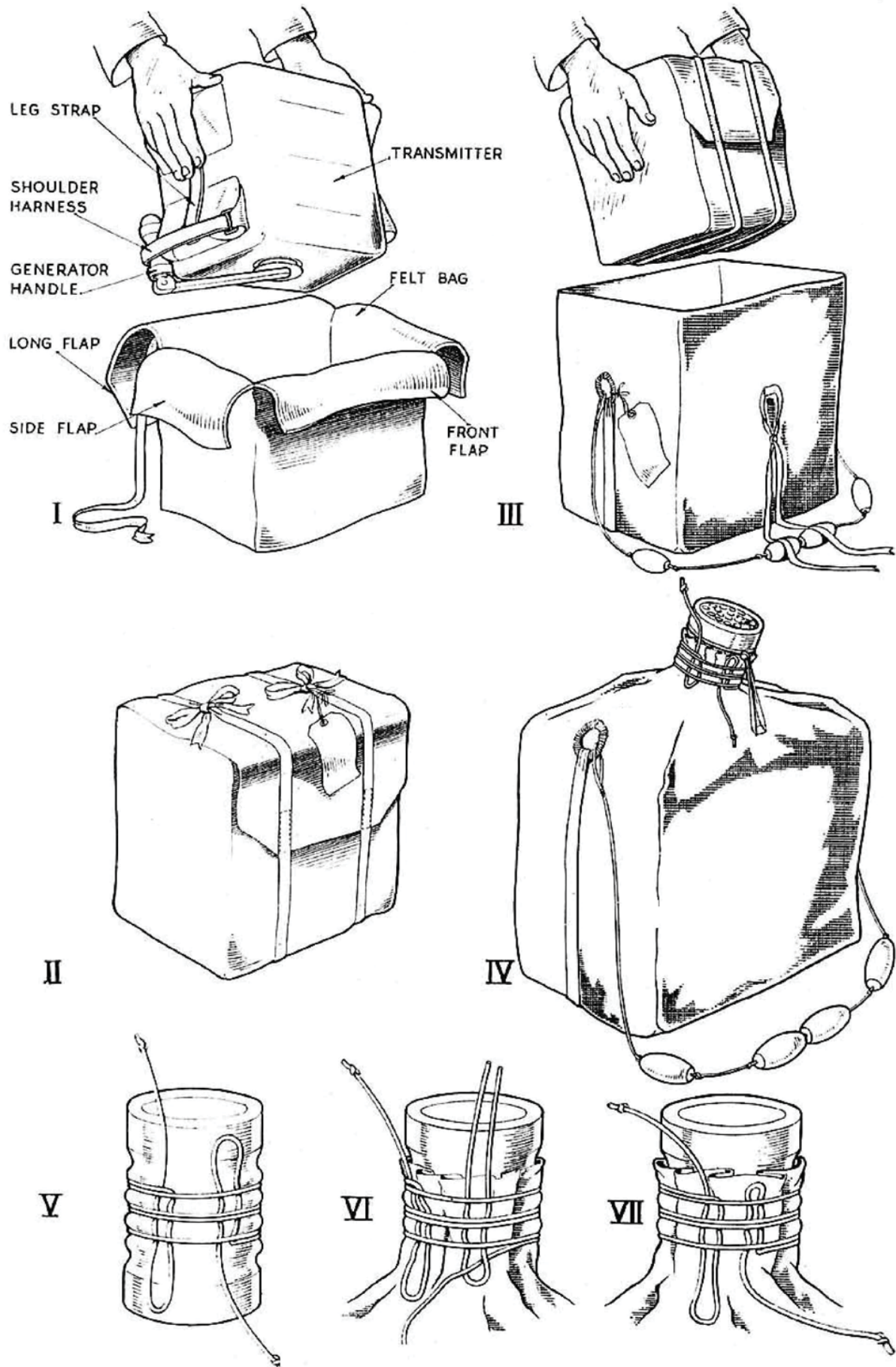


FIG. 7—METHOD OF PACKING TRANSMITTER IN FELT AND WATERPROOF CASES

tapes K and lanyard handle L on the waterproof case should also be in the position shown. It is essential that the transmitter be in the position shown in order that the bag will float the correct side up.

- (iv) Pleat the mouth of the waterproof case around the breather valve. Flat folds should be employed and lashed as shown at (vi) and (vii) to make the case watertight. The tapes K on the outer case are tied round the top groove of the breather valve so that it is tilted at an angle of about 45 deg. (knot M) in which position it will be above the surface of the water.
- (v) This diagram shows the valve and lashing cord as supplied; it indicates the method of lashing as described below.
- (vi) The procedure of lashing is shown in this diagram. A loop of cord is used to pull the bottom end under the lashing, the loop being finally withdrawn.
- (vii) The ends of the lashing are finally adjusted to leave two knotted ends of cord approximately 6 in. long at top and bottom so that a strong pull on either will release the valve from the bag.
- (viii) The transmitter must be mounted in the aircraft in the position shown by fig. 8 (i.e. control panel uppermost) and the quick release strap should be well padded with the beaded lanyard underneath.

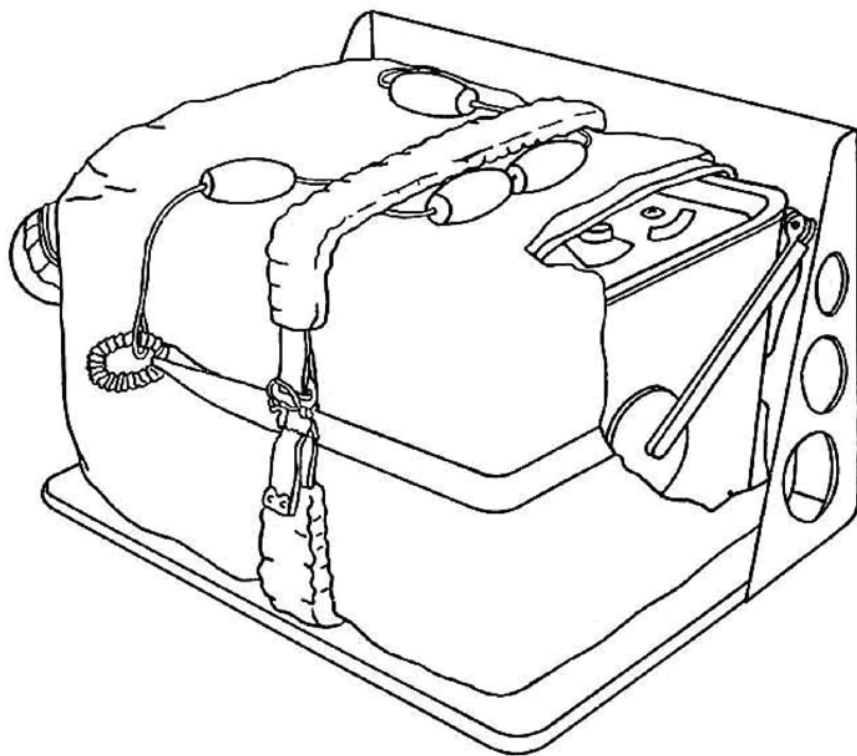


FIG. 8—METHOD OF MOUNTING TRANSMITTER IN AIRCRAFT

ROCKET KITE AERIAL

37. The aerial is supported by a kite which is launched into the air by means of a rocket fired from a Verey pistol. The kite, folded up and contained in a case, is drawn up by the rocket, and when it reaches the height determined by the length of attached line (200 ft.) it is stripped of its case and opens automatically. In a wind of 6 m.p.h. or over it will remain aloft. The aerial is then attached to the line and the kite allowed to rise, carrying the aerial to the requisite height of about 208 ft. Both case and rocket fall away.

38. Two kites and associated launching apparatus are carried and these are packed in a single container approximately 3 ft. long with a cross section of 7 in. by 3 in. The container is made of laminated plastic material and is divided into three compartments.

39. In each of the two outer compartments is placed one kite in a cover and in the centre compartment are two rockets each of which is connected to one of the kites by a tow line. The assembly arrangements are clearly shown in fig. 9. The second kite is intended as a reserve. Also

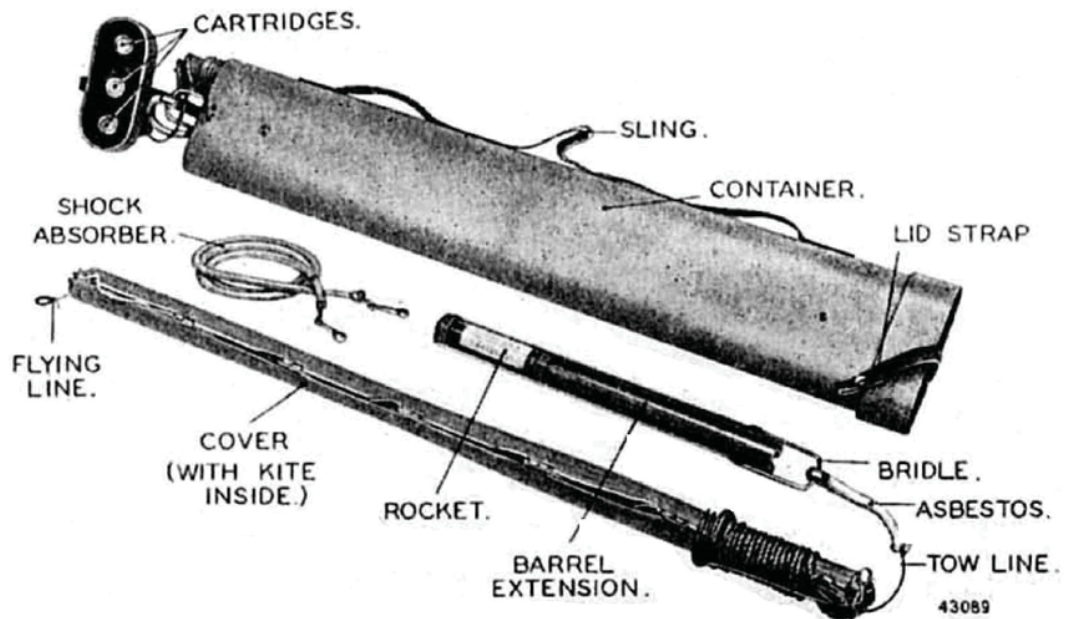


FIG. 9—ROCKET KITE CONTAINER WITH ONE KITE (IN COVER) AND ROCKET REMOVED

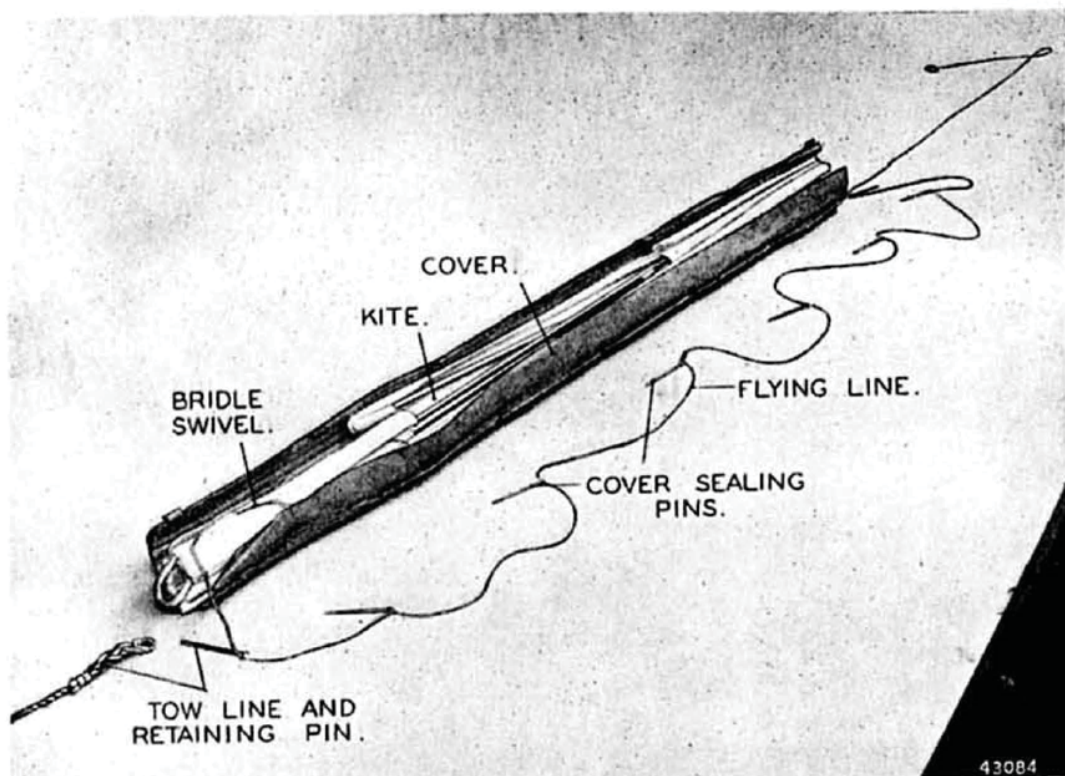


FIG. 10—KITE IN ITS COVER WITH SEALING PINS WITHDRAWN AND COVER PARTLY OPEN

in the container are an elastic shock absorber by which the kite line is attached to the dinghy before launching, a barrel extension for fitting to the Verey pistol and three cartridges. The kites are folded up inside corrugated stiff paper cases and the 200 ft. of flying line is housed in the corrugations in such a manner that it will pay out freely when the kite assembly is launched.

40. The kite cover (see fig. 10) is opened by the pull of the line when it reaches the limit of its length; the pull releases quickly detachable pins. It is absolutely essential for the correct functioning of the apparatus that the kite be folded in the correct manner and properly packed in its retaining cover. Full instructions for carrying out this work are given in Chap. 5, Sect. 8, Part 3, Vol. I of A.P.1182 to which reference should be made.

41. A complete list of the items constituting the rocket kite apparatus is given below:—

Container, kite and rocket	Cartridges (3) 1 in., kite, Mk. I
Kite, collapsible, Mk. II	Barrel extension
Kite cover	Flying line
Rocket, launching, Mk. II	Shock absorber

42. The kite is made of light fabric stretched over a frame made up of four light metal alloy tubes. This frame is collapsible. Attached to the face of the kite are a pair of stabilizers carried on a common light wooden spar to which the line bridle is attached, the line being secured by a small metal swivel.

43. Reference to fig. 11 will show the construction of the kite and the manner in which, when it is folded with all frame members together and parallel, it will open out by reason of the pull exerted by the two elastic straps. These straps are stranded elastic and when the kite is closed are under considerable tension. It will be seen that the two cross pieces of the frame each terminates in a pocket in the fabric at one end and on the further main member at the other at which point it is fitted with a clip which is capable of sliding along the main member. Half way between the two main members the cross pieces are pivoted together and at this point a rubber ring is doubled round in order to assist the opening action which is as follows. When the kite is released from its cover the elastic straps pull the ends of the cross members along the main members until the sliding clips reach stops on the members; the kite is then fully open.

44. At each top corner of the kite is a loop of webbing pinned into the top of the frame and sewn to the fabric. The rocket line is attached through these two loops and held by a split pin which is pulled out at the end of the limit of travel of the flying line. The rocket is thus freed from the kite which then begins to open.

45. The cover in which the kite is packed consists of stiff paper, with stitched double corrugations for the whole of its length on one side, there being seventeen corrugations, i.e. thirty-four in all. The flying line is threaded first into each corrugation of the lower row and then into each corrugation of the upper row. Along each edge of the cover are eyes or hinges by means of which the cover may be kept closed by six split pins threaded through the eyes; these pins are secured to the flying line. The flying line passes out through the lower end of the cover and is made fast to the dinghy before the rocket is fired. When the jerk occurs at the end of the flying line travel the pins are pulled out in quick succession and the cover is forced off under the expanding action of the kite inside it.

46. The rocket is mounted in a bridle (see fig. 9) consisting of two tubular members attached to two transverse hoops which fit the rocket tightly, the leading hoop at the head of the bridle being secured to the rocket by a screw. The rear end of the bridle is hinged and at the end of the hinged piece a wire cable about 4 ft. long is attached, a part of the cable being covered with asbestos to protect it from heat during flight. To the end of the wire cable is attached a cord with two spliced eyes, one long and the other short. The long splice is looped through and over an eye spliced in the end of the wire cable and the short eye is attached to the two loops in the top of the kite, being held in position by a split pin. As soon as the split pin is withdrawn the rocket tow line is freed from the kite.

47. The pistol used for firing the rocket is the standard 1 in. signal pistol to which an extension tube about 1 ft. long is fitted by means of a bayonet slot that engages with a small stud on the side of the pistol barrel. The rocket fits into the barrel extension. The cartridges used are a special type and the ordinary signal cartridges are unsuitable.

48. A shock absorber is provided on the flying line at the bottom end. This consists of about 4 ft. 6 in. of cased elastic fitted with a spring snap hook at each end. One hook is made fast to the ring at the end of the flying line and the other to one of the fabric rings on the dinghy to which the life line is attached.

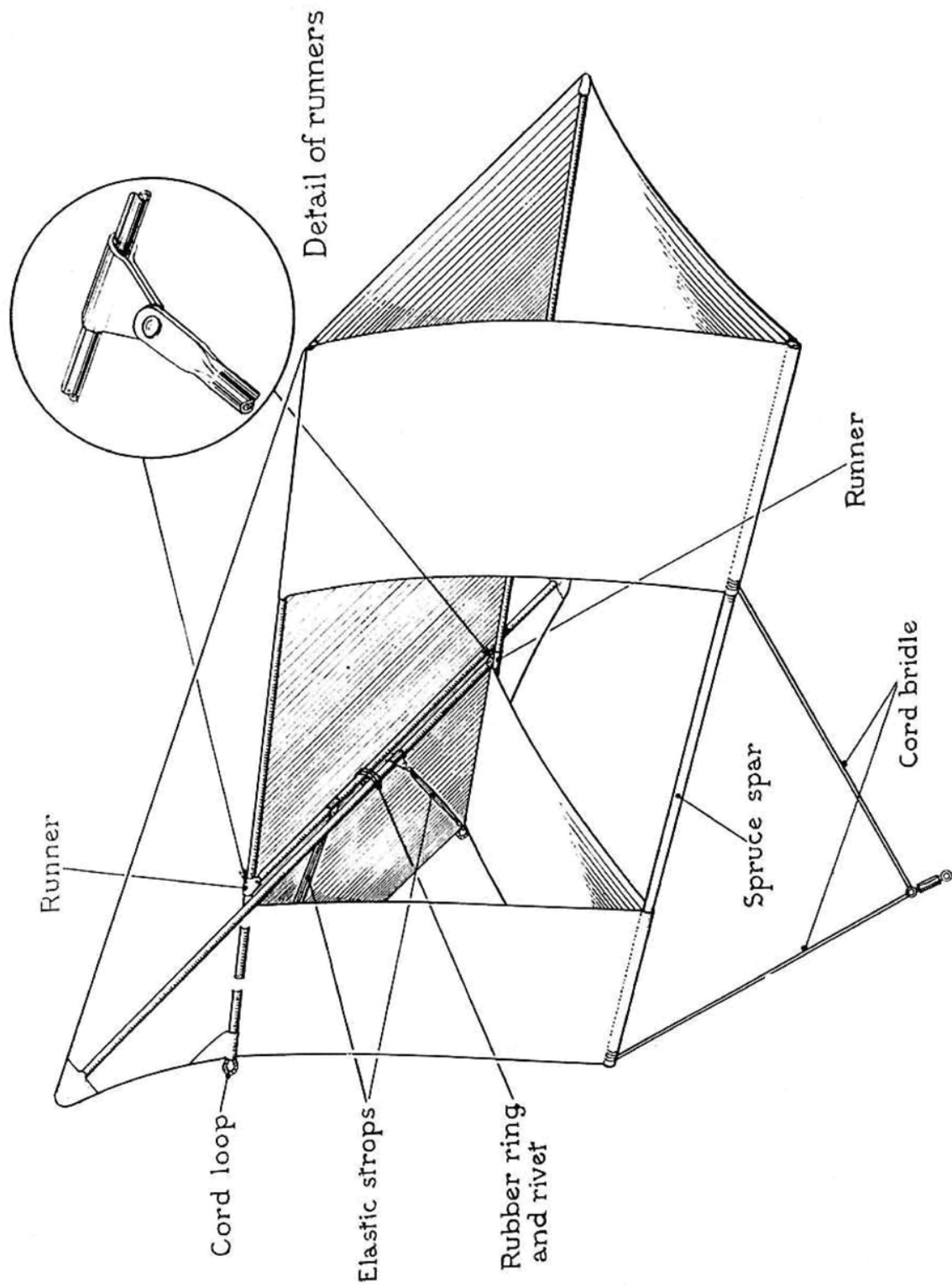


FIG. 11--KITE FULLY OPEN OUT OF ITS COVER

OPERATION

49. The equipment is used in the following manner, after the transmitter and rocket kite have been collected into the dinghy and the sea drogue of the dinghy has been put overboard to check drift.

50. *Rocket kite operation.*—

- (i) Undo the sealing straps at each end of the container and open both ends.
- (ii) Remove from the container one kite with rocket attached, the pistol barrel extension and the shock absorber. The barrel extension will be found *in situ* on one of the rockets. The shock absorber will be found stowed with the other rocket in the container so that it is necessary to open both ends of the latter.
- (iii) Attach one end of the shock absorber by means of its spring hook to a fabric ring through which the life line passes on the outside wall of the dinghy and on the side of the dinghy opposite the sea drogue. Ensure that the shock absorber is clear of obstructions such as the rescue line and sheath knife stowage on the dinghy. Attach the other end of the shock absorber by means of its spring hook to the ring on the end of the kite flying line.
- (iv) Unwrap the rocket line from the kite cover (round which it is wound for stowage) and lay the kite on the floor of the dinghy with the top end resting on the side of the dinghy at an angle of about 45 deg. See that the shock absorber and the lower end of the kite and flying line are clear of any obstruction on the floor of the dinghy.
- (v) Take the signal pistol from the emergency pack, load it with a cartridge from the container lid but do not cock the pistol.
- (vi) Fit the barrel extension to the pistol and put a rocket in the extension so that the hinged piece of the rocket bridle is under and not above the pistol.
- (vii) See that the tow line connecting the rocket to the top of the kite is clear of all obstructions.
- (viii) Sit on the floor of the dinghy in line with and directly behind the kite. See that the shock absorber is on your left-hand side of the kite and the rocket tow line is on the right-hand side and once again that both are quite clear of any other equipment or possible obstructions (see fig. 12).
- (ix) Ensuring that the kite is pointing down wind, cock the pistol, raise it to an angle of about 70 deg., also down wind (in the same direction as the kite is pointing) and fire the pistol.
- (x) The rocket should ignite immediately and carry the kite up with it and at the end of the travel of the line the kite will disengage from its cover and fly at the end of the line.
- (xi) Taking a turn round the wrist with the flying line, disconnect the ring at the end of the flying line from the shock absorber.

51. *Transmitter operation.*—

- (i) Open aerial winch door. Throw earth weight in sea. Hook aerial to kite line ring.
- (ii) Pull out winch handle. Pay out the aerial steadily by unreeling it. Hook aerial to lead-in. Tie leather thong to hauling-in line in dinghy to take kite tension off lead-in.
- (iii) Unclip pocket and raise handle to cranking position. Unscrew lock ring fully counter-clockwise.
- (iv) Select "Auto CW".
- (v) Grip set between knees and secure knee straps.
- (vi) Crank for 30 seconds to warm valves and turn tuning knob until lamp gives maximum glow.
- (vii) Turn steadily at 120 r.p.m. on C.W. and M.C.W. alternatively.
- (viii) To release the knee straps quickly pull both buckle loops upwards.

52. It should suffice to turn the generator handle for periods of 5 minutes every quarter of an hour at a speed of approximately 120 revolutions per minute. Care should be taken to avoid contact with the uninsulated portion of the aerial wire while the transmitter is being operated.

53. When it is required to close the transmitter down, the aerial wire should be unhooked from the lead-in and attached to the small hook on the reel. The earth line and aerial lead-in are wound round the lugs in the panel compartment and the aerial wound up and detached from the kite, after which the aerial case is closed and secured with the retaining pin which is resealed with the spare wire provided. Finally, the generator handle grip should be folded down and the locking ring under the handle screwed down to make the case watertight.

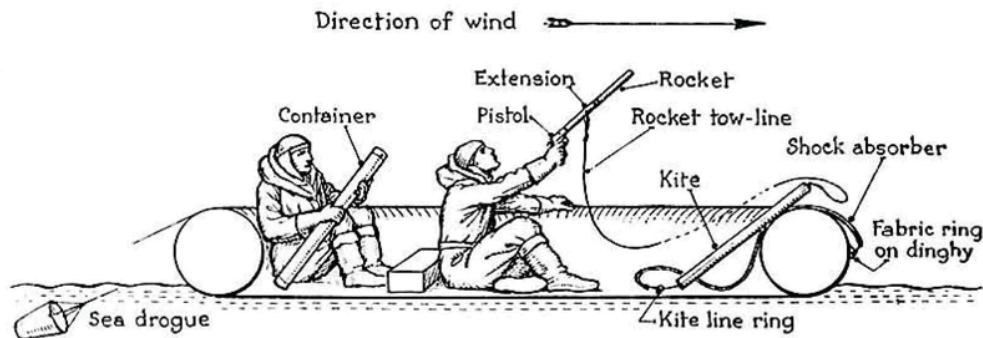


FIG. 12—SKETCH SHOWING METHOD OF FIRING ROCKET

PRECAUTIONS AND MAINTENANCE

54. As this type of transmitter is only likely to have limited use, the amount of maintenance work necessary should be small, but routine checks must be made as described later. Although the case is watertight, it is not airtight and with varying atmospheric pressures at different altitudes there is the possibility of the ingress of water vapour. Limited amounts of moisture will be absorbed by the silica-gel unit but it will be necessary to dry or replace the element at suitable intervals, the length of which will depend on the conditions of use of the apparatus and climatic conditions.

55. Tuning is liable to vary with variations from the perpendicular of the aerial in varying winds owing to alterations of capacity; repeated checks of the maximum brightness of the indicator lamp should therefore be made while the equipment is in operation.

Operational check

56. The correct operation of the equipment should be checked before each operational flight. This is done by measuring the power output obtained into the external artificial aerial load. This aerial load should consist of a capacity of 360 to 500 μF in series with a 30-ohm resistance, the outer end of the latter being earthed. The most suitable value for the capacity is 430 μF plus or minus 16 per cent and it can be obtained either by using a variable condenser or a suitable arrangement of fixed condensers. An artificial aerial (Stores Ref. 10B/13281) is available. The checking procedure is as follows. Fig. 13 shows how the transmitter should be operated.

- (i) Open winch door.
- (ii) Connect end of aerial lead-in to aerial terminal of load.
- (iii) Connect earth lead to earth terminal of load.
- (iv) Set generator handle by unclipping pocket, raising hand piece and unscrewing locking ring, fully counter-clockwise.
- (v) Set service switch to HAND M.C.W.
- (vi) Turn handle steadily for half-a-minute at 120 r.p.m. to warm up filaments.
- (vii) Press hand key and tune by turning tuning knob until neon lamp gives maximum glow, or until the aerial load ammeter (if used) gives maximum reading. This should be approximately 0.4 amp.
- (viii) Repeat (vii) above on HAND C.W. (key pressed).
- (ix) Repeat on AUTO M.C.W. and note sequence of signals by observing flashing of neon lamp (or fluctuations of aerial ammeter).
- (x) Repeat on AUTO C.W. The correct sequence of signals on AUTO is twelve long dashes followed by three S.O.S. signals. One long dash signal should be approximately four seconds duration followed by a one-second interval. The time for ten such signals should be between limits of 45 and 55 seconds.
- (xi) When satisfied that the equipment operates correctly, the earth wire must first be wound carefully into the front panel recess round the lugs provided, followed by the lead-in. The winch door should then be closed and the securing pin reinserted and sealed with a short length of the wire provided for this purpose (25 s.w.g. tinned copper).

Fault location

57. In the event of the equipment not operating satisfactorily it may be due to corrosion, the ingress of water or an electrical fault may have developed. Fault location charts are given in fig. 14. A general internal inspection should first be made by removing the front panel. This can be done by removing the twenty 4 B.A. screws round its edge and gently easing it away from the case, thus breaking the seal formed by the gasket. The panel should be drawn off carefully, avoiding damage



FIG. 13—VIEW SHOWING CORRECT METHOD OF OPERATION

to the inter-unit pins, valves, etc. Any parts which show corrosion or leakage should be treated according to the nature of the damage. In general, the following points should particularly be checked.

- (i) Aerial lead-in elbow.—If signs of leakage at this point are present, the retaining nut should be slackened and the tapered surfaces of the elbow resealed with bakelite varnish. The nut should then be retightened carefully.
- (ii) Service switch and tuning spindle glands.—Remove knob and gland nuts. The felt rings inside the gland nuts can be repacked with anti-freeze grease or replaced if damaged. The surfaces of the nuts in contact with the front panel should be smeared with bakelite varnish before re-assembly.
- (iii) Hand key.—If there are leaks at this point, the rubber diaphragm should be inspected and replaced if damaged. The diaphragm should be lightly smeared with Bostik. The centre nut must not be over tightened so as to cause the gasket to be squeezed out from under the washer and the eight 8 B.A. nuts must be tightened evenly, a little at a time. The key action must be definite and clean and not indeterminate and spongy.
- (iv) Neon windows.—If there are leaks at the neon window, the rubber gasket should be replaced, the nuts being tightened evenly.

- (v) Generator handle gland.—To obtain access to the driving handle gland, unscrew the locking ring fully counter-clockwise and remove the handle by unscrewing the hexagon-headed screw at the centre. This screw has a left-hand thread and therefore must be unscrewed clockwise. It can be undone by quick movements of the spanner against the inertia of the generator armature. Attempts to prevent the armature rotating should not be made. The packing gland is in the annular recess around the spindle. The packing should be removed and replaced with a new one after carefully cleaning the recess. When re-assembling the handle, ensure that the driving tongue engages correctly with the slot in the generator shaft and turn counter-clockwise to check that the ratchet is operating.
- (vi) To remove generator and sub-panel.—The generator and sub-panel must be removed together in the following sequence: Remove the generator handle as described in (v); remove Ozokerite wax and undo seven screws at the handle end of case; remove four panel retaining screws (inside case) after which the generator and panel may be carefully eased out, taking care not to damage the mechanism under the panel by contact with the mounting pillars.

58. When the generator is out of the case, access to the commutators and brush gear can be obtained by removing the four inspection covers. Inspect for chipped or cracked brushes and if in order replace in original positions. The commutators may be cleaned with a soft rag and carbon tetrachloride. Emery cloth must on no account be used, but if scoring has taken place they may be lightly cleaned with the finest sand paper. Examination of the gear box should be made by removal of the cover plate. If water has penetrated, the old grease should be removed, and the box repacked. Care must be taken when re-assembling the generator in the case not to omit the four distance pieces and the felt washer between the case and generator. The felt washer must be soaked in molten anti-freeze grease before being fitted and melted Ozokerite wax should be run in over the heads of the seven holding screws.

Voltage regulator adjustment

59. The adjustment of the voltage regulator of the generator should not be altered unless necessary. Should it have been disturbed, it should be re-adjusted as follows: Energize the coil with 8 volts D.C. across terminal 1 and 3 (fig. 12). Adjust contact gap to 0.012 in. and tighten the lock nut, using the test circuit fig. 15 with terminals 1 and 2 short circuited; adjust voltage across terminals 2 and 3 to 6.7 volts. Then adjust back stop so that voltage drop across terminals 1 and 3 is less than 6.7 volts and more than 6.3. Finally, lock all adjusting screws and coat them with bakelite varnish.

Interruptor unit adjustment

60. Owing to the delicate nature of the interruptor unit it should not be dismantled, but the following checks can be made and the adjustment corrected as necessary. The rotor should oscillate freely and not have more than 0.0015 in. end play (equal to one eighth turn of bearing screw). The contacts should be in alignment and rest on their back springs with a light pressure. At normal, the rotor teeth should be out of alignment with keepers in a clockwise direction, so that corners overlap by 0.010 in. to 0.030 in. upper contacts to be broken and lower contact pressure to be not less than 5 grammes measured at edge of contact bracket on rotor. With interruptor in any position and $5\frac{1}{2}$ to 7 volts D.C. applied (with a 25 μ F condenser connected across contacts), the impulse rate should be $4\frac{1}{2}$ to $5\frac{1}{2}$ per sec. The rate of oscillation can be adjusted by rotating the hair spring bracket. It is essential that the convolutions of the spring are quite free, and this can be accomplished by loosening the screws securing the bracket and moving it laterally.

Selector adjustment

61. For the correct operation of the selector unit, the following conditions should obtain. The cam assemblies must be individually free on their respective spindles. Gear wheel and pinion should mesh freely with the minimum amount of backlash. The retaining pawl should be two or three teeth behind the driving pawl. It should rest lightly at the base of the tooth and there should be minimum backward movement of the cam when the armature restores. The armature back stop should be set to allow the driving pawl to drop back over one tooth during release; the maximum permissible back movement is $1\frac{1}{2}$ teeth. Contact springs should be adjusted so that the contacts are in alignment when touching, with the springs approximately at right angles to the block.

Electrical faults

62. The tests outlined in the two fault-finding charts given by fig. 14 should preferably be made with batteries by removing the front panel of the transmitter (see para. 57) and connecting 320 volts to H.T. and 6 volts to L.T. pins. If batteries are not available, checks can be made on

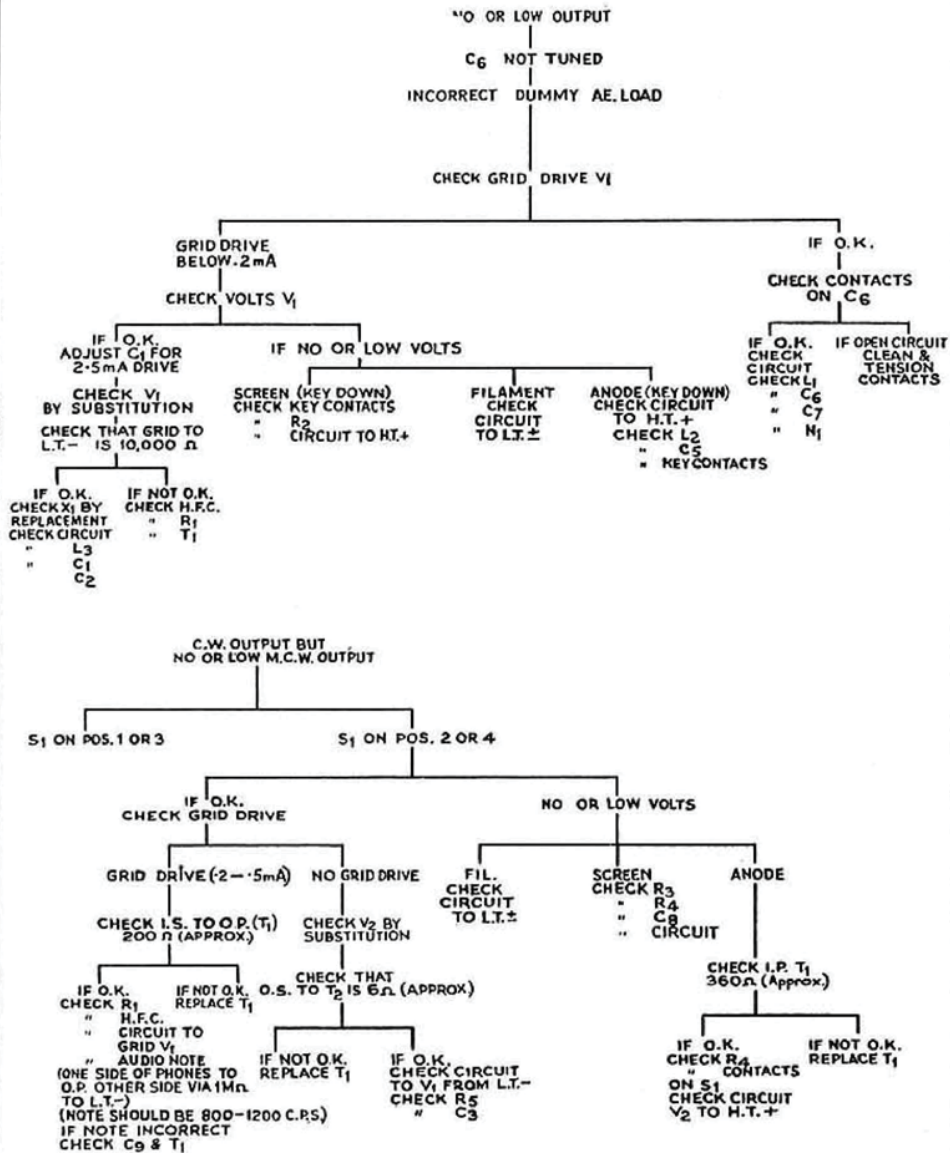


FIG. 14

FAULT LOCATION CHARTS

FIG. 14

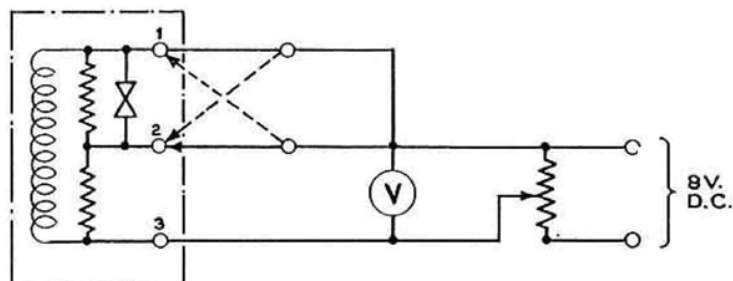


FIG. 15

VOLTAGE REGULATOR TEST CIRCUIT

FIG. 15

the hand generator, but the front panel should be removed and the 5-pin plugs and sockets connected up with extension leads; this permits of easy access to the components. In order to ensure steady readings on the meter the generator handle should be turned at approximately 130 r.p.m. so that the voltage regulator will be operating.

63. The grid current readings of V_1 should be taken by disconnecting the lead to I.S. of transformer T_1 and inserting the milliammeters between I.S. and this lead. Grid current readings of V_2 are taken by disconnecting the lead to the earthy end of resistance R_5 and inserting the meter between R_5 and L.T.—.

64. A test of the operation of the auto-key unit is made by connecting together terminals L.T.— and KEY 2 of the 5-pin socket and turning the generator handle.

Silica-gel desiccator

65. The silica-gel desiccator must be regenerated or replaced after (i) six months, (ii) breaking the air-tight condition of the equipment (e.g. after internal inspection or repair) and (iii) immersion of the equipment in water.

66. The desiccator is regenerated by removing the screw cap of the container and withdrawing the bag which is then heated in an oven for a period of one to two hours at a temperature that will not char the bag (approx. 250 deg. F.). The bag should then be replaced in its case immediately, care being taken to see that the leather washer is in position and the cap screwed on tightly. This drying-out process can be repeated indefinitely, but the bag must not be left exposed to the air before insertion in its container.

67. After operational use which has resulted in the immersion of the equipment in water it should be examined for external damage and signs of leakage. The silica-gel desiccator should be examined and if it is excessively damp, the front panel should be removed and the interior equipment examined after which the routine checks described in para. 56, should be made.

68. Before the front panel is replaced, the edge of the case should be cleaned and the gasket examined to see that it is in good condition. Care must be taken to engage the interplug and socket correctly, after which the screws can be inserted and tightened down a little at a time, so that the pressure will be evenly distributed. The two countersunk holes and screw heads must be clean in order to ensure a good earth connection.

69. Full instructions on the maintenance and packing of the rocket kite apparatus are given in A.P.1182, Vol. I, Part 3, Sect. 8, Chap. 5. As the correct functioning of the gear depends upon its proper folding and packing it is imperative that those instructions be followed in detail.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
10D/1422-	Transmitter, type 1333B	1	—	Emergency transmitter for use in dinghy
	Principal components:—			
10C/79	Choke Type	1	—	H.F., 1.5 mH
10R/13003	Coil, aerial tuning Type	1	—	Pile wound, 58 turns, Litz wire
10R/13004	Coil, anode coupling Type	1	—	Wire wound, 112 turns
10R/13005	Coil, tuning Type	1	—	Iron dust core, 89 turns
	Condenser			
10C/5028	Type 2698	1	C ₁	20 to 120 μ F., ceramic
10C/4999	Type 2689	1	C ₂	250 μ F., 1,000 volts
10C/3190	Type 1545	1	C ₃	0.1 μ F., 450 volts
10C/8496	Type 188	1	C ₄	0.01 μ F., 350 volts
10C/3055	Type 1465	1	C ₅	0.01 μ F., 500 volts
10C/4979	Type 2669	1	C ₆	Variable with switch and glands
10C/5020	Type 2690	1	C ₇	4 μ F., 500 volts
10C/8190	Type 1545	1	C ₈	0.1 μ F., 450 volts
10C/8496	Type 188	1	C ₉	0.01 μ F., 350 volts
10C/4980	Type	1	C ₁₀	25 μ F., 25 volts
	Type	1	C ₁₁	0.2 μ F.
	Crystal			
10X/500	Type	1	X ₁	500 kc/s
	Drying charge			
10D/3087	Type 1	1	—	Silica-gel in linen bag
	Holder, valve			
10H/493	Type 73	2	—	
	Lamp, indicating			
10E/484	Type 671	1	N1	Neon
	Resistance			
10C/7017	Type 7017	1	R ₁	10,000 ohms, $\frac{1}{2}$ watt
10C/1274	Type 1274	1	R ₂	10,000 ohms, 1 watt
10C/7181	Type 7181	1	R ₃	5,000 ohms, $\frac{1}{2}$ watt
10C/6221	Type 6221	1	R ₄	50,000 ohms, 1 watt
10C/6005	Type 6005	1	R ₅	50,000 ohms, $\frac{1}{2}$ watt
	Valve			
10E/349	Type 6V6G	1	V ₁	American octal
10E/352	Type 6J7G or KTZ63	1	V ₂	American octal
	Wire, aerial			
	Type			
	Artificial aerial			
10B/13281	Type 18	1	—	

SECTION 1, CHAPTER 14.

TRANSMITTERS, T.1259 AND T.1302
(Stores Refs. 10D/202 and 10D/609)

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INTRODUCTION

1. The transmitters T.1259 and T.1302 have been designed for fixed or mobile use and are basically similar, both as regards circuit arrangements and construction. There are, however, some differences in the circuits and the layout of the components which necessitate separate descriptions being given. Five other models have also been developed but they only include minor modifications and have been produced singly. It is not, therefore, proposed to describe these. Both the T.1259 and T.1302 transmitters are rated for the same output of 2 kW for C.W. operation and 500 W. for telephony and C.W. operation, but the frequency range differs.

TRANSMITTER T.1259

General description

2. The transmitter, type T.1259, will provide an output of 2 kilowatts at any frequency between 110 kilocycles and 1,200 kilocycles, provision being made for operation at half, one-quarter and one-sixteenth power on continuous wave. The carrier power is reduced to 500 watts on modulated

continuous wave and telephony. The frequency range is covered by four separate wave bands as given below:—

Long-wave extension ...	110 to 150 kc/s.
Long-wave band ...	150 to 300 kc/s.
Medium-wave band ...	300 to 600 kc/s.
Short-wave band ...	600 to 1,200 kc/s.

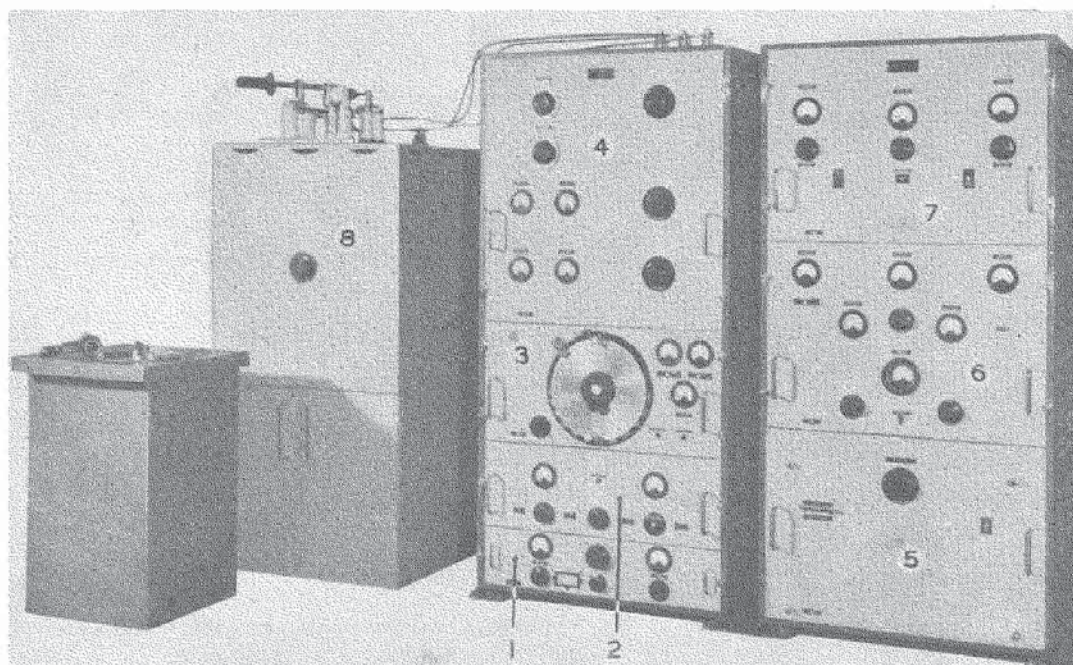


FIG. 1.—TRANSMITTER T.1259

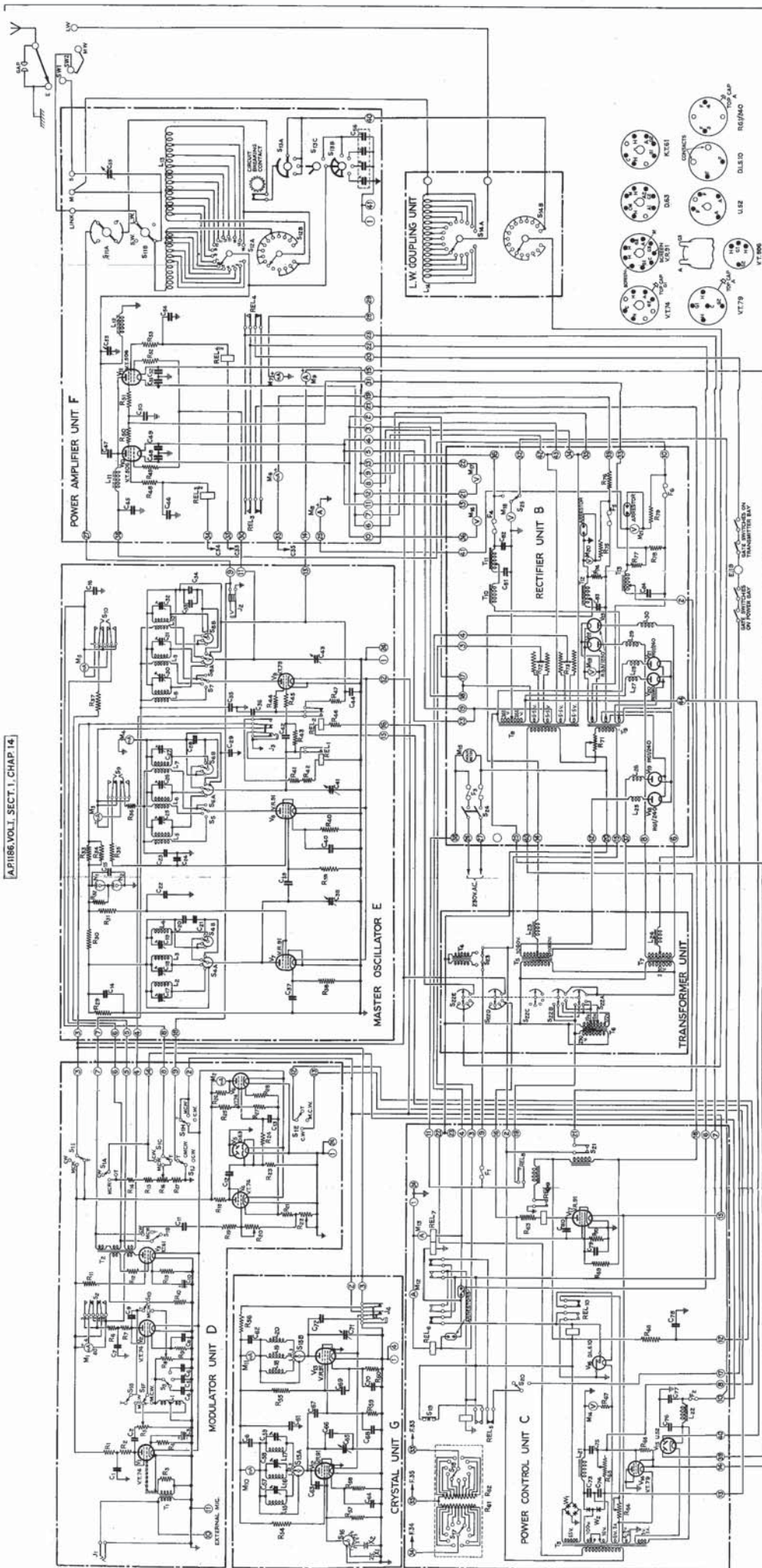
3. A view of the T.1259 transmitter is given in fig. 1, and it will be seen that it consists of two steel bays which contain the various units. The units in the bay at the left comprise (from bottom to top) (1) the crystal unit, (2) the modulator unit, (3) the master oscillator, (4) the power amplifier. The units in the bay at the right comprise (from bottom to top) (5) the power supply unit, (6) the rectifier unit, (7) the control unit. The case (8) at the extreme left contains the output circuit arrangements for long wave and long-wave extension only. Each of the units in the two steel bays, with the exception of the power supply unit, is built on a separate chassis and is immediately removable by pulling it out from the front. The complete circuit diagram of the transmitter is given in fig. 2, and a diagram showing the interconnections of the various units in fig. 3.

Modulator

4. The modulator unit, which is shown by figs. 4 and 5, employs six valves. The first of these V_1 , which is a type V.T.74, is the first microphone amplifier, and another valve V_2 , of the same type, is the second microphone amplifier. These two valves are resistance-capacity coupled and they feed the grid of the modulator valve V_3 , which is an Osram KT61; this modulates the anode supply of the driver valve in the master oscillator. A large amount of negative feed-back is provided on the modulator valve V_3 , in order to reduce distortion to a negligible amount.

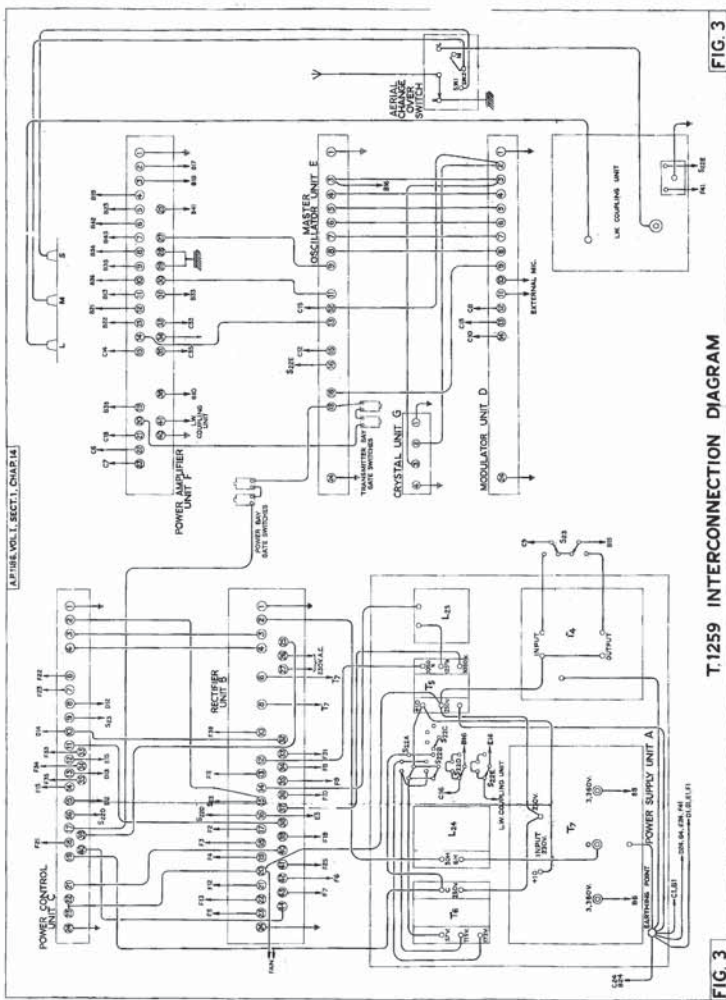
5. A modulation monitor is included in the modulator circuit which provides a direct reading of the peak modulation, and a delay circuit is incorporated which enables momentary peaks to be maintained for several seconds in order to provide a correct indication of transmitter overloading. The modulation monitor employs a type V.T.74 valve, V_4 , as buffer amplifier, an Osram D63, V_5 , as diode rectifier, and a type V.T.74 valve, V_6 , as linear D.C. amplifier to drive the modulation monitor meter M2.

6. When operating on M.C.W., the second microphone amplifier V_2 , is adjusted to oscillate at an audible frequency which may be approximately 700 cycles per second, 1,000 c/s or 1,400 c/s. This setting is secured by means of a wander plug and socket arrangement which is provided on the deck of the modulator chassis. Controls are included for adjustment of the degree of amplification from the microphone, and also for the modulation level of modulated C.W. service. In addition there are controls for the set zero of the modulation meter M2, and for the H.T. supplied to the driver valve of the master oscillator when modulation is required.



T.1259 CIRCUIT

FIG. 2



T.1259 INTERCONNECTION DIAGRAM

FIG. 3

Master oscillator

7. Rear and underside views of the master oscillator are given by figs. 6 and 7. The circuit of the master oscillator employs a dynatron oscillator V_7 (type V.R.91), which is followed by a buffer-doubler V_8 (type V.R.91) and a final driver valve V_9 (type V.T.79). The circuit includes three tuned circuits, A, B and C, and the switches, coils and variable condensers used in these are matched and ganged in order to permit of one-knob tuning of the unit. The master oscillator valve V_7 is a type

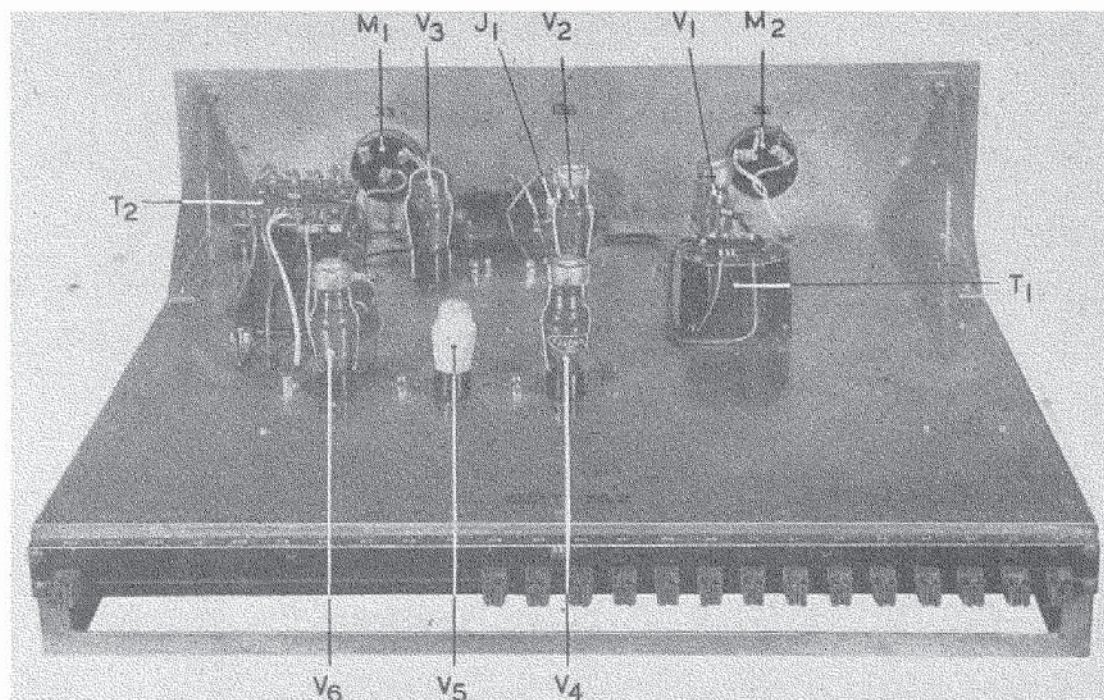


FIG. 4.—MODULATOR UNIT—REAR VIEW

V.R.91, which operates as a dynatron. This valve, and the buffer doubler valve V_8 , which is also type V.R.91, are mounted, together with the various decoupling resistances and condensers, in a separate tank-shaped sub-assembly provided with a removable top and bottom. The temperature compensated coils L_2 , L_3 and L_4 , used for the master oscillator, are also contained in this tank.

8. The frequency range is covered in four bands of (a) 110 to 150 kc/s., (b) 150 to 300 kc/s., (c) 300 to 600 kc/s., (d) 600 to 1,200 kc/s., any one of these being selected by the ganged wave-change switch S4A to S8B on the front panel. The master oscillator circuit is tuned by the temperature compensated variable condenser C_{38} .

9. The H.T. voltage for the master oscillator valve V_7 is obtained indirectly from the flux regulated transformer T4 *via* transformer T8 in the rectifier unit, and is further stabilised by means of the two series connected neon lamps N_1 and N_2 . The filament voltage for this valve is obtained indirectly from the flux regulated transformer T4 *via* transformer T3 in the control unit.

10. The output from the buffer-doubler valve V_8 is fed to the grid of the driver valve V_9 , and the output of the tuned anode circuit of this valve is used to drive the grids of the two parallel-connected power amplifier valves V_{10} and V_{11} . For telephony service and for modulated continuous-wave transmissions, modulation is effected on the anode of the driver valve V_9 . The two power amplifiers are arranged to operate as linear class-B.R.F. amplifiers.

11. Keying is accomplished by switching the screen of the driver Valve V_9 from the grid bias supply of the power amplifiers to the H.T. supply by means of a high-speed changeover relay REL.2. Meters M_3 and M_5 are provided to measure the anode and screen currents of the buffer-doubler valve V_8 , and the anode, screen and grid currents of the driver valve V_9 , respectively.

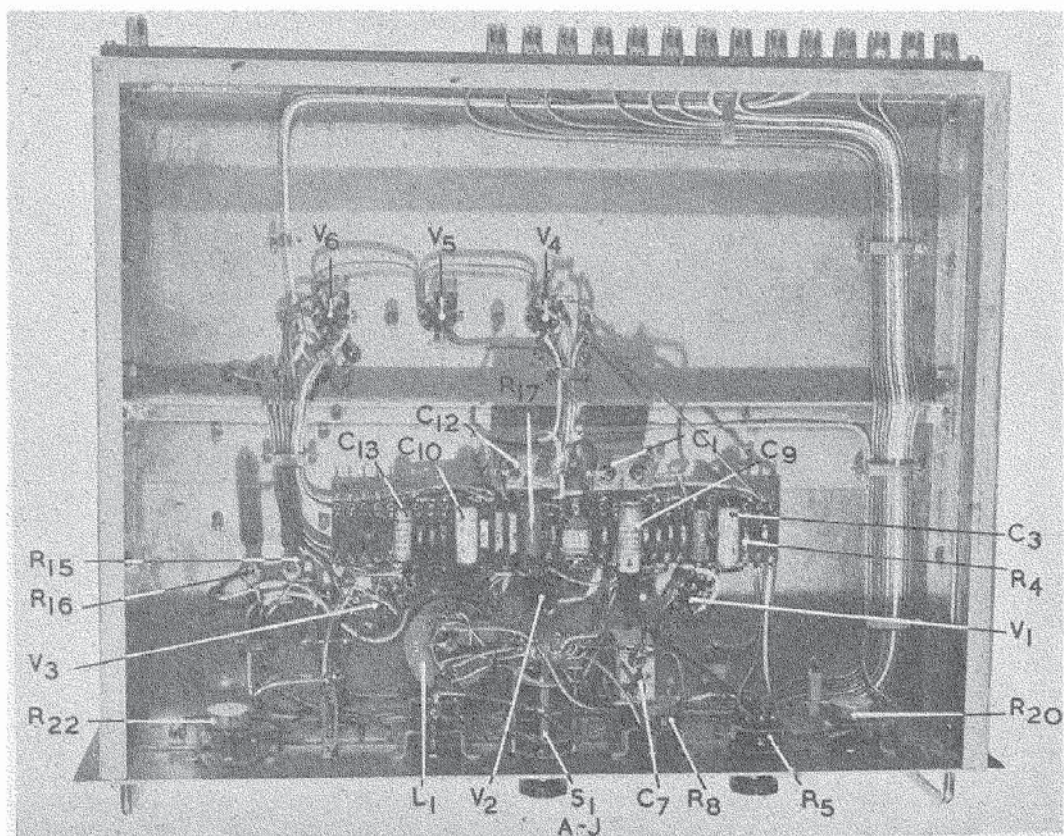


FIG. 5.—MODULATOR UNIT—UNDERSIDE

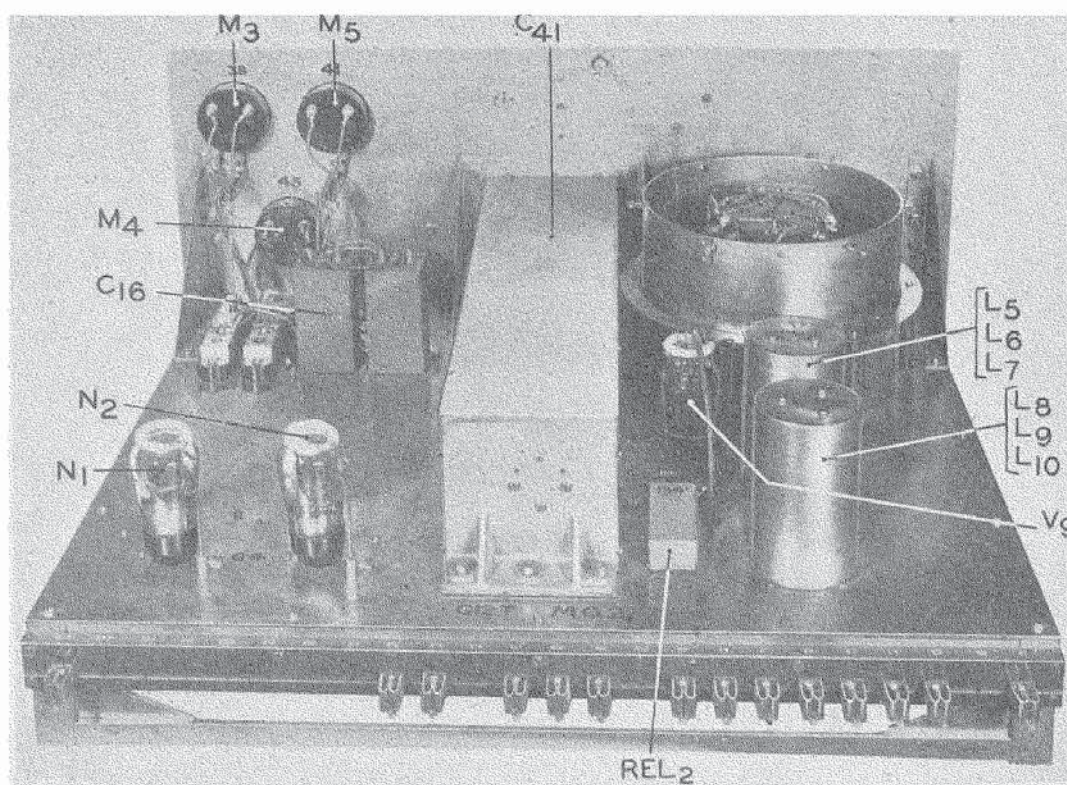


FIG. 6.—MASTER OSCILLATOR—REAR VIEW

Crystal master oscillator

12. The crystal master oscillator circuit incorporates two valves V_{12} and V_{13} , both of which are type V.R.91. The first of these, V_{12} , is connected as a triode in the usual crystal oscillator circuit, and the second, V_{13} , is used as a buffer amplifier. The output from the crystal unit is connected to the inductance capacity master oscillator unit (Unit E) by a special low-capacity screened lead which is fitted at each end with a jack plug. The unit is put into service automatically when the jack plug

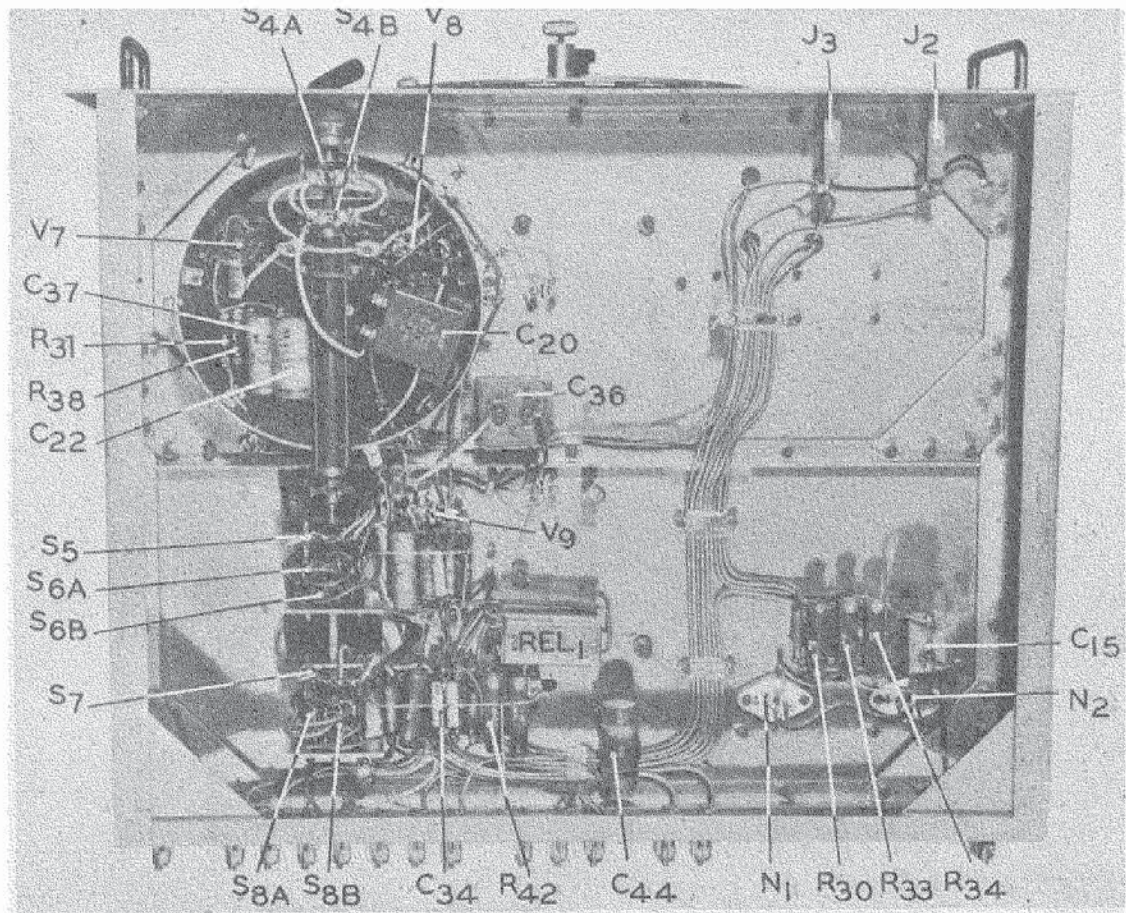


FIG. 7.—MASTER OSCILLATOR—UNDERSIDE

is inserted in the output socket. When the other end of the screened lead is inserted in the E unit crystal oscillator jack socket, all necessary changes are made in the circuit to enable the transmitter to operate directly from the crystal unit.

Power amplifier

13. The power amplifier, which is shown by figs. 8 and 9, employs two pentode valves, V_{10} and V_{11} (type V.T.506), connected in parallel. The anodes of these valves are supplied with approximately 2,850 volts H.T. through the high-frequency choke L_{11} . The R.F. output from these valves is taken *via* the blocking condenser C_{47} in order to isolate the H.T. voltage from the tuning coils and output circuit.

14. The short-wave band is tuned by means of a variable air-dielectric condenser C_{55} , a tapped coil L_{18} and an oil-filled tank condenser C_{53} which are either all in series as shown in fig. 10 or in a low pass filter circuit (fig. 11), the feed from the output valves being applied across the oil condenser. The aerial impedance on this band is inductive.

15. On the medium-wave band, where the aerial impedance changes from resistive to capacitive, the arrangements are fundamentally the same, except for the omission of the air-dielectric condenser C_{55} . Additional capacities, C_{58A} , C_{58B} , C_{58C} , C_{58D} , can be switched in in six steps in parallel with the oil condenser C_{53} . The total capacity thus formed constitutes the principal control of loading and the switch S_{12A} the principal control of tuning.

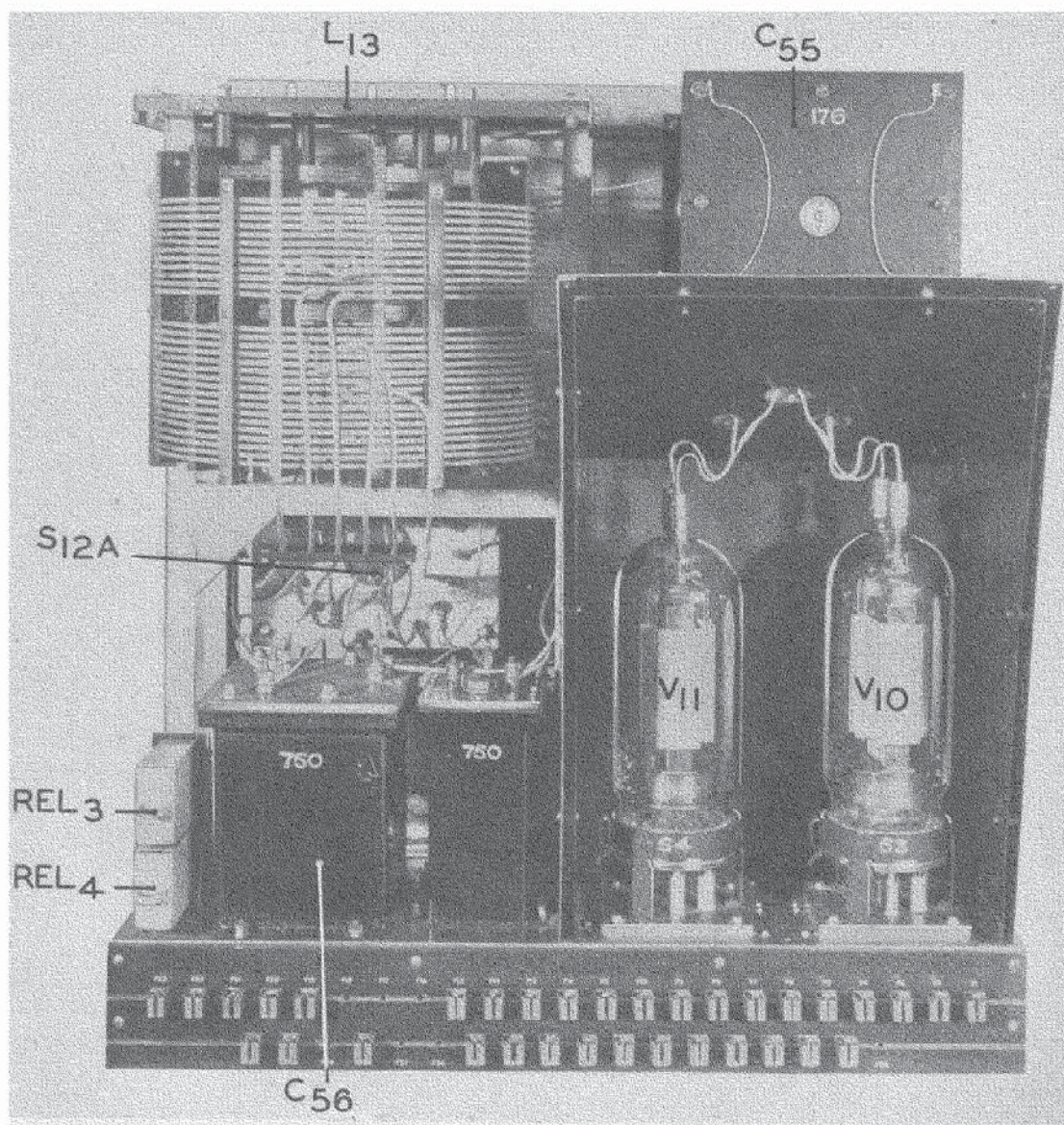


FIG. 8.—POWER AMPLIFIER—REAR VIEW

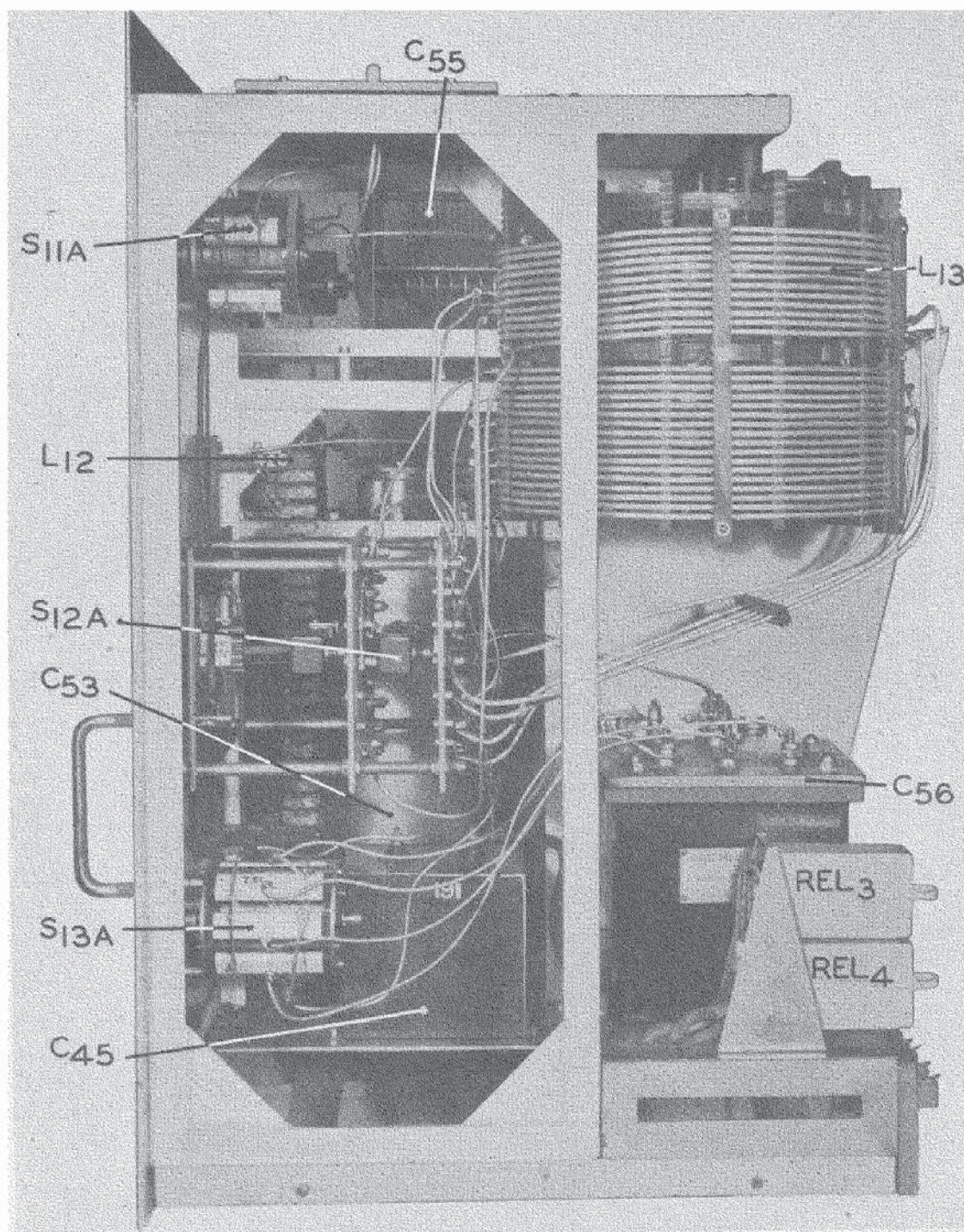


FIG. 9.—POWER AMPLIFIER—SIDE VIEW

16. On the long-wave and long-wave extension bands, the fundamental circuit remains the same, but a tapped aerial loading coil is again connected in series.

17. Overload cut-outs REL.3, REL.4, are provided for the screens of the power amplifiers, and also meters M_9 , M_6 and M_8 to read the power amplifier grid current, screen current and anode currents respectively. In addition a 0-25 thermo-ammeter M_7 is connected in the main earth lead to indicate the output of the transmitter.

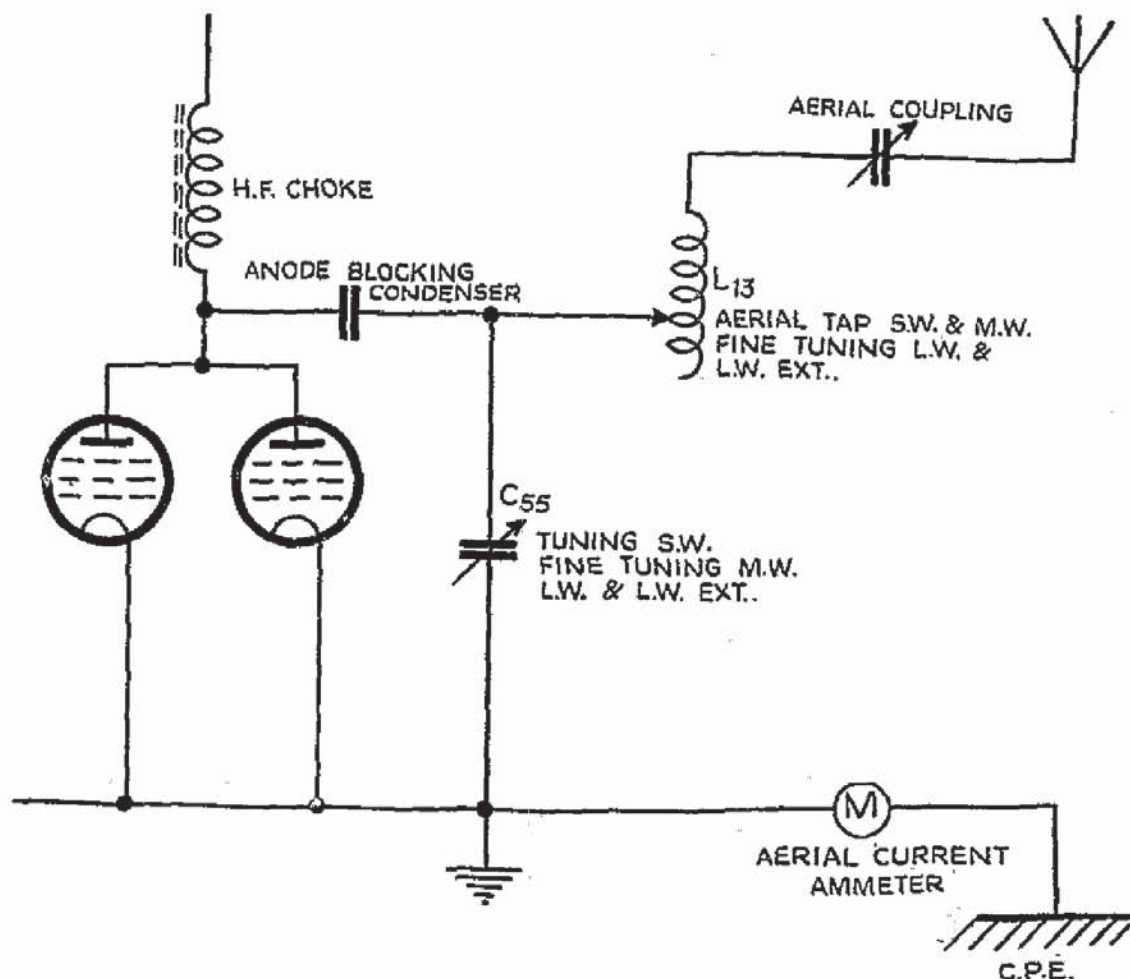


FIG. 10.—SHORT-WAVE TUNING CIRCUIT

Power supplies

18. The transmitter is designed to operate from a single-phase, 230-volt, 50-cycle input, and the power consumption is approximately $4\frac{1}{2}$ kilowatts at full power. The rectifier and transformer units are shown by figs. 12 and 13 respectively.

19. The supplies which are available from the power unit are as follows, and these feed all parts of the equipment:—

- (i) 50 to 60 volts unsmoothed D.C. by means of a full-wave bridge rectifier for the operation of relays, contactors, etc.
- (ii) Grid bias supply for the power amplifiers at approximately 240 volts for C.W. operation and about 200 volts for modulated service.
- (iii) 6.3 volts A.C. for heating the filaments of the valves in the modulator, master oscillator, and crystal unit circuits.
- (iv) 6.3 volts A.C. for the operation of the relay valve V_{16} protecting the mercury-vapour rectifiers, and for the power amplifier grid bias stabilising valve V_{14} .
- (v) Three sets of 4 volts A.C. for heating the three pairs of mercury-vapour rectifiers, V_{18} , V_{19} , V_{20} , V_{21} , V_{22} , V_{23} .
- (vi) 300 volts smoothed D.C. for the master oscillator and crystal oscillator units and the five seconds delay valve V_{17} .

- (vii) 2,850 volts smoothed D.C. for the power amplifier valves V_{10} and V_{11} .
- (viii) 1,000 volts smoothed D.C. for the screen supply to the power amplifiers V_{10} and V_{11} .
- (ix). 450 volts smoothed D.C. for the H.T. supply to the driver valve V_9 .

20. A rear view of the power control unit is shown by fig. 14. With the main supply connected and the main ON-OFF switch S_{24} in the ON position, the filaments of the mercury-vapour valves V_{18} to V_{23} will be heated, the 50-volt control voltage will be available and also the grid bias supply to the power amplifier valves V_{10} and V_{11} . The delay valve V_{16} (DLS10) is fitted to prevent the application of H.T. to the mercury vapour rectifier valves before their cathodes have attained correct operating temperature. The delay valve (V_{16}) is provided with a tungsten filament which is heated by A.C. current. This filament heats a bimetallic strip inside the delay valve, which is deflected

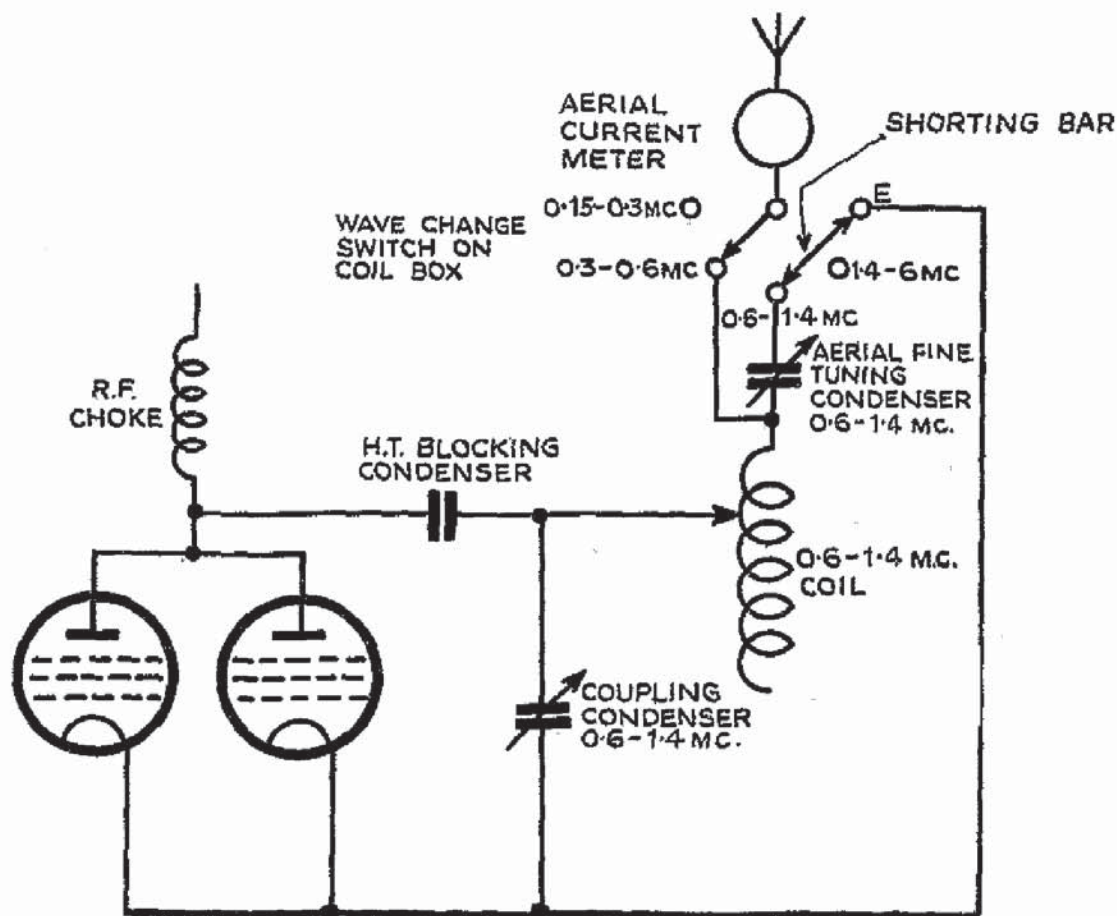


FIG. 11.—1.2 TO 1.4 MC/S TUNING CIRCUIT

sufficiently to touch a contact inside the valve which operates the self-holding relay REL_{10} on the control chassis. The time period of the delay is controllable by means of a coin-operated screw on the front of the control unit of the power amplifier unit. With the STAND-BY-ON switch S_{20} in the ON position, this relay connects the coil of the small displacement type mercury switch S_{21} to the 50-volt D.C. supply, and this connects the primary of the transformer feeding the 300-volt H.T. supply for the low-power stages of the transmitter and the filaments of the power amplifiers. The completion of the coil circuit of this mercury contactor also short-circuits, through a resistance, a condenser C_{70} , which has been charged up to 50 volts negative from the control supply and which was impressed as bias on the grid of the second delay valve V_{17} .

21. The 300-volt H.T. supply is connected through the coil of the relay REL_9 to the anode of the five-second delay valve V_{17} , and after a delay due to the time taken by the resistance R_{70} to discharge the condenser C_{70} , the grid bias of the second delay valve V_{17} is sufficiently reduced to enable anode current to flow and operate the relay. The contacts of relay REL_9 connect 50 volts D.C. to the coil of the main contactor REL_8 , and this in turn connects the anode and screen supplies to the power amplifier valves V_{10} and V_{11} .

CONSTRUCTION

22. The complete T.1259 transmitter consists of three main units, and reference to fig. 1 will show that these are divided into seven separate chassis, excluding the loading coil unit which is contained in a separate case. The main units comprise:—

- (i) Transmitter unit.
- (ii) Power supply unit.
- (iii) Long-wave coil unit.

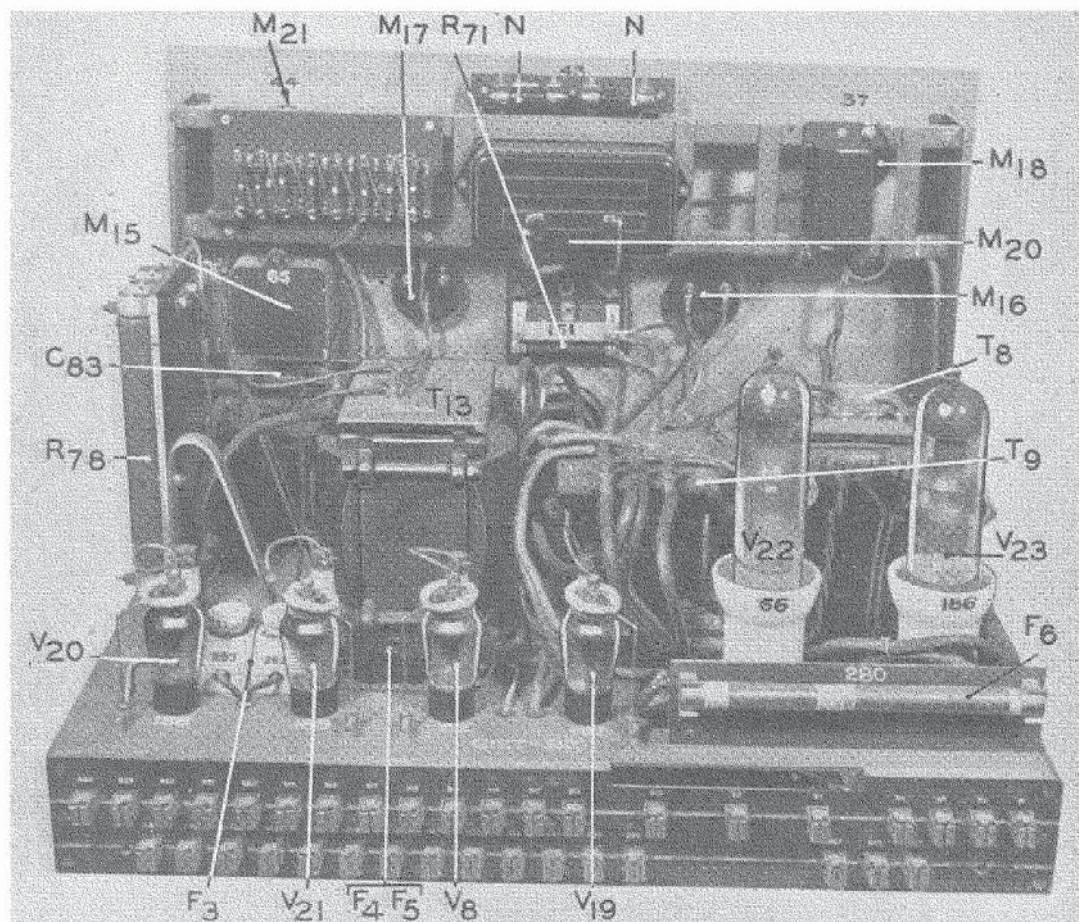


FIG. 12.—RECTIFIER UNIT—REAR VIEW

23. Each chassis, with the exception of the power supply assembly, consists of a panel and base assembly on which are mounted all the components and controls of the particular unit. The power supply components are mounted directly in the main steel case and the unit is accessible when the other units above it are removed. Contacts at the rear of each chassis provide the necessary inter-unit connections and any one can, therefore, be removed from the main containing case by merely pulling it out from the front. The transmitter and power supply unit are interconnected by means of a large multi-core cable. The long-wave coil unit is contained in a separate wooden case situated at the left of the power supply and transmitter units as shown in fig. 1.

24. The transmitter is provided with a main ON-OFF switch S_{21} and a subsidiary STAND-BY-ON switch S_{20} . Safety devices are fitted on the rear gates which cause the transmitter to close down immediately either gate is opened. Screen and overload cut-outs are also fitted to the main power amplifiers, and each of the various stud switches that are used for tuning is provided with a breaking device which ensures that they break on zero current. Each overload cut-out is fitted with one set of "make" and "break" contacts, "make" occurring before "break". All "make" contacts are connected in parallel and all "break" contacts in series. When any one of these overload cut-outs operates, the "make" contacts energise the coil of a self-holding trip provided with one set of "make" and one set of "break" contacts. The "break" contacts of all the overload cut-outs and the trip relay are in series with the STAND-BY-ON switch S_{20} . When any cut-out operates, the coil of the

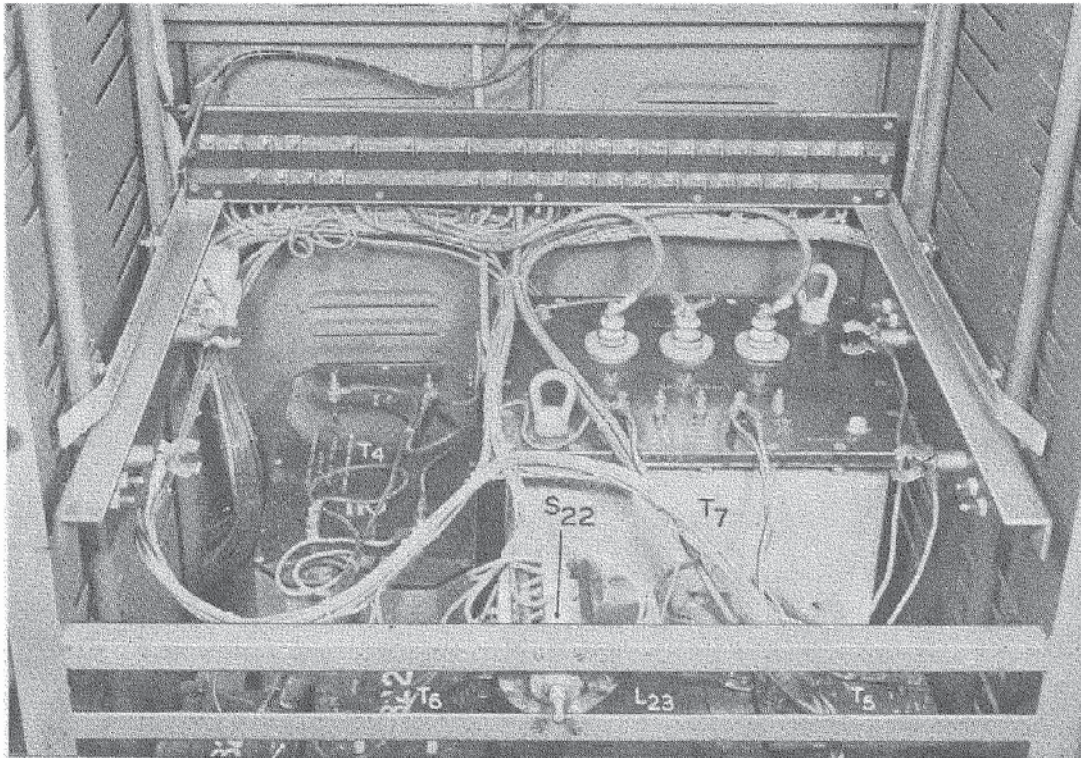


FIG. 13.—TRANSFORMER UNIT

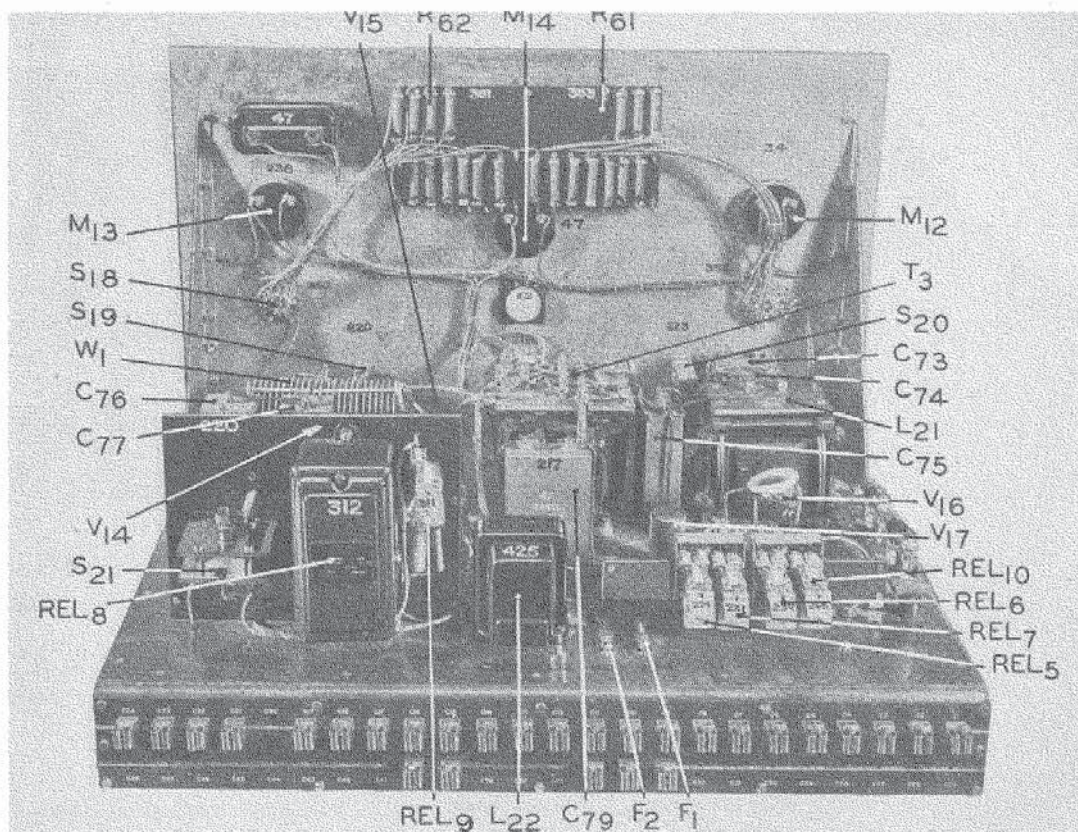


FIG. 14. POWER CONTROL UNIT

small displacement mercury switch S_{31} is disconnected from its supply, and this switch, therefore, opens and switches off the H.T. supply of the low-power stages and the filament voltage of the power amplifier. In addition, as this H.T. voltage operates the main contactor switch, this also is open circuited. Once the trip relay REL_5 has been energised, the whole transmitter is closed down until the PUSH-TO-RESET trip switch S_{19} is operated.

OPERATION—T.1259 TRANSMITTER

25. The method of operating the transmitter differs according to the type of service required, i.e. telephony (TEL.) and modulated continuous wave (M.C.W.) or continuous wave (C.W.). Operating instructions for each are therefore given separately. The transmitter must not under any conditions be operated without a sound earth connection.

Continuous wave

26. When the transmitter is to be operated on C.W. it is important that before it is tuned, the power control switch S_{22A} and S_{22B} , located on the bottom of the right-hand bay, be set not higher than quarter power. This setting may be increased when tuning has been accomplished.

27. The following is the preliminary sequence of operations after the aerial and earth connections have been made:—

- (i) Ensure that all rear gates are securely closed.
- (ii) Switch on the mains supply (230 volts, 50 cycles)
- (iii) Set the MAIN GENERATOR switch S_{23} according to the source of supply.
- (iv) Set the STAND-BY-ON switch S_{20} (on the top left-hand side of the right-hand bay) to the STAND-BY position.
- (v) Raise the main ON-OFF switch (on the same bay) to the ON position.

28. The rectifier filament voltmeter M_{19} should now give readings and, by means of the control R_{71} , these should be adjusted to 4 volts. A voltage will also be shown on the power amplifier grid bias meter M_{14} .

29. After a delay of about one minute, necessitated by the time required for the mercury-vapour rectifier valves to come into operation, the transmitter will be ready for service. It will be found that even if the transmitter is started with the STAND-BY-ON switch in the ON position, it will not start until the delay period has elapsed.

30. With the STAND-BY-ON switch still at the ON position, set the switch S_{1A} to S_{1J} on modulator panel at the bottom of the left-hand bay marked TEL - M.C.W. - C.W. to the C.W. position.

31. The required operating frequency is now obtained by ascertaining into which band it falls and setting the wave-change switches accordingly, as described below.

- Long-wave extension between 110 and 120 kc/s.
- Long-wave between 150 and 300 kc/s.
- Medium-wave between 300 and 600 kc/s.
- Short-wave between 600 and 1,200 kc/s.

Three band-change switches are provided:—

- One on the power amplifier unit S_{11A} and S_{11B} .
- One on the master oscillator unit S_{4A} to S_{8B} .
- One on the long-wave coil box which is situated on the left of the transmitter.

32. Each of these switches must be set to the band required, and then the master oscillator dial at the middle of the left-hand bay must be set to the exact frequency required by means of the calibration charts supplied with the instrument.

33. After these adjustments have been made, the STAND-BY-ON switch S_{20} may be put into the ON position and then, after 5 seconds delay to enable the power amplifier valves to attain their operating temperature, the transmitter will automatically switch itself on.

34. The meters M_{16} and M_{17} on the rectifier unit (filament volts power amplifier 1 and 2) should now both read 10 volts and, if these voltages are not shown, the controls on the rectifier unit (R_{72} and R_{73}) should be adjusted until they are correct.

35. The meter (M_{18}) marked H.T. VOLTS LOW-POWER STAGE should read 500 volts, the meter (M_{20}) marked SCREEN VOLTS POWER AMPLIFIER about 450 volts, the meter (M_{21}) marked H.T. VOLTS POWER AMPLIFIERS between 1,500 and 1,600 volts, and the meter (M_{14}) marked GRID BIAS POWER AMPLIFIERS about 250 volts; the cathode current meters M_{12} and M_{13} should read zero amps.

36. With the above settings correct the morse key may now be depressed and current should be indicated on the meters marked CATHODE CURRENT POWER AMPLIFIERS, ANODE CURRENT POWER AMPLIFIERS, and SCREEN CURRENT POWER AMPLIFIERS. About 40 milliamps. should be indicated on the meter marked GRID CURRENT POWER AMPLIFIERS.

37. All tuning switches and the power control switch, but not the band-change switches, may be operated when the transmitter is working, even with the key down, up to one-quarter power, as the circuit arrangements are such that the movement of any of these switches from its click position causes the whole transmitter momentarily to close down until the switch concerned has reached the next stud position. It will be clear that no current will show on these meters when the key is depressed if any switch is in between click positions; if, therefore, no current flows on pressing the key, it is necessary to ascertain which switch is incorrectly set.

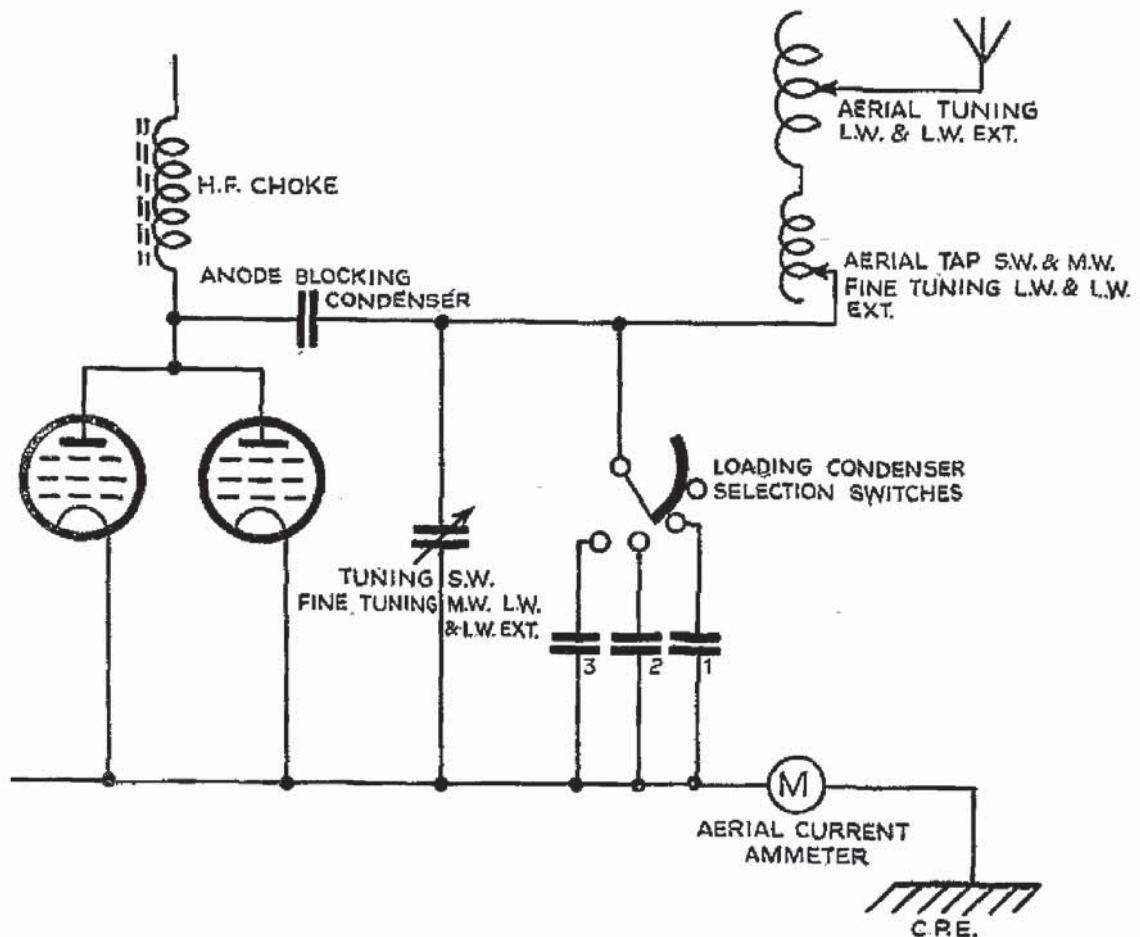


FIG. 15.—LONG AND MEDIUM WAVE TUNING CIRCUIT

Tuning—long-wave band

38. The fundamental circuit of the long-wave band tuning arrangement is given in fig. 15. To tune the output circuit it is necessary to bring the circuit formed by the aerial capacity, tuning coil, and coupling condensers into resonance. In order to obtain the correct coupling to the output valve it is also necessary that the coupling condensers be adjusted to the correct value to give an anode current of 1 to 1.2 amps. on full power when the circuit is in tune. The smaller the value of coupling capacity, the lower does the "on-tune" anode current become. If an increase in coupling capacity is made, a corresponding decrease in inductance must be made to keep the circuit in tune.

39. The following procedure in tuning the long-wave or long-wave extension bands will enable the principles described in the foregoing paragraph to be carried out.

- (i) Set the POWER CONTROL switches S_{22A} to S_{22E} to quarter power.
- (ii) Set the AERIAL CHANGEOVER SWITCH to the LONG-WAVE position.
- (iii) Make sure that the service switch S_{1A} to S_{1J} on the modulator unit is set to C.W.
- (iv) Set the wave-band switches on the master oscillator unit to L.W. or L.W.EXT. and those on the power amplifier to L.W./L.W.EXT.
- (v) Press the key to ascertain the readings on the power amplifier anode current meter M_8 and the screen current meter M_6 . The transmitter is now ready for tuning.
- (vi) Set the oscillator to the frequency required on long-wave or long-wave extension bands.
- (vii) Set the condenser dial C_{53} , marked TUNING S.W. BAND/FINE TUNING M.W. L.W., to the mid-position.
- (viii) Set the switch S_{13A} to S_{13C} , marked LOADING CONDENSER SELECTOR, to position 1.
- (ix) Set the aerial switch S_{12A} , S_{12B} , marked AERIAL TAP S.W. M.W./FINE TUNING L.W. L.W. EXT., to the mid-position.
- (x) Press the key and rotate the switch on the long-wave coil box, marked AERIAL TUNING, to a position which can be judged approximately from the frequency. For example, at 150 kc/s set it to 16; at 225 kc/s set it to 9; and at 300 kc/s set at 1 or 2.
- (xi) Swing the condenser C_{53} , marked TUNING S.W./FINE TUNING M.W. L.W., until the resonant point is found; this point is found by a large dip in anode current. If no dip is indicated, alter the setting of the AERIAL TUNING switch one notch, up or down, and swing the condenser again. If the anode current dips to a value of less than 0.5 amp. the loading is too light and should be increased by reducing the setting of the switch, marked AERIAL TAP S.W./FINE TUNING L.W./L.W.EXT. by one notch, and increasing the capacity to give resonance again by turning the condenser C_{53} , marked TUNING S.W./FINE TUNING M.W./L.W., in a clockwise direction. This procedure should be continued until the anode current reads 0.5 amp. When the condenser is all in at 0 degrees bring it back to 300 degrees and switch in another loading condenser by setting the switch to 2. When the FINE TUNING inductance O_{13} is all out at position 1 return it to a high setting and reduce the AERIAL TUNING switch on the long-wave coil box one notch.
- (xii) With the morse key UP, switch the transmitter to full power; this operation should be performed slowly. Check that the anode current is between 1 and 1.2 amps. If it is outside these limits, return to quarter power and re-adjust the loading.
- (xiii) Check that the two cathode current meters M_{12} and M_{13} read the same. If the readings are not the same, reduce the higher by means of the cathode current controls S_{17} , S_{18} , on the power amplifier unit. Initially both controls should be set for maximum current, so that only one should be used.
- (xiv) Finally, it is of the utmost importance that the anodes of the output valves are not run at a temperature higher than cherry red at their brightest part.

Tuning—Medium wave band

40. The fundamental circuit for the medium-wave band is again the same as for the long-wave band, but the coil used on the long-wave and long-wave extension bands for fine tuning is now the only tuning inductance. At aerial resonance the aerial appears as a pure resistance of about 30 ohms. Tuning and loading are carried out as already described, but any change in the tapping position requires a large change in the condensers, as they are now the only capacity in the circuit. The operational procedure, therefore, is as follows:—

- (i) Set the OSCILLATOR WAVE-CHANGE switch S_{4A} to S_{4B} to MEDIUM-WAVE position.
- (ii) Set the AERIAL CHANGEOVER switch to MEDIUM-WAVE.
- (iii) Set the WAVE-CHANGE switch S_{11A} and S_{11B} on the power amplifier unit to M.W./S.W.
- (iv) Set the POWER CONTROL switch S_{22A} to S_{22E} to quarter power.
- (v) Adjust the OSCILLATOR dial to the frequency required.
- (vi) Proceed with tuning as for long-wave. *Note.*—As the frequency is raised from 120 kc/s upwards, the loading capacity required becomes less and less.

Tuning—Short-wave band (low-frequency end)

41. On the short-wave band the aerial appears inductive. The fundamental circuit is given in fig. 10 and, although the circuit elements are different, the fundamental circuit remains as before. The inductance is formed by the aerial in series with the coil, and the capacity by the aerial coupling condenser in series with the tuning condenser C_{53} . Thus, when the aerial coupling condenser C_{53} is all in and the tuning condenser C_{53} is all out, the loading is the lightest possible.

42. The tuning procedure on the short-wave band is as given below:—
- (i) Set the OSCILLATOR WAVE-CHANGE switch S_{4A} to S_{8B} to S.W.
 - (ii) Set the AERIAL CHANGEOVER switch to S.W.
 - (iii) Set the POWER CONTROL to quarter power.
 - (iv) Set the OSCILLATOR dial to the required frequency.
 - (v) Set the LOADING CONDENSER SELECTOR switch S_{13A} to S_{13C} to zero.
 - (vi) Set the AERIAL COUPLING condenser C_{55} to maximum, i.e. 180 degrees.
 - (vii) Set the AERIAL TAP switch S_{12A} , S_{12B} , to position 16, and swing the TUNING S.W./FINE TUNING M.W. L.W. condenser from 300 deg. to 0 deg. If there is not any sign of resonance, reduce the setting of the AERIAL TAP switch S_{12A} , S_{12B} , one notch and swing the condenser again. Continue this procedure until resonance is found.
 - (viii) If the anode current at resonance is less than 0.5 amp. the loading is too light; this is increased by reducing the AERIAL TAP one notch and increasing the TUNING S.W./FINE TUNING M.W. L.W. condenser to give resonance again. The AERIAL COUPLING condenser C_{55} should be left at maximum. If it is found that a change of one notch makes too big a change in the loading, the AERIAL COUPLING condenser C_{55} should be reduced slightly and the TUNING S.W./FINE TUNING M.W. L.W. condenser increased to resonance again. The aerial coupling condenser should always be set to the maximum possible value, otherwise it is liable to spark over.

Tuning—Short-wave band (high frequency end)

43. If difficulty is found in tuning the circuit as described, the elements may be rearranged as shown in fig. 11. The tuning procedure is then the same as that for the short-wave band.

Telephony and M.C.W. operation

44. When used on telephony and M.C.W. service, the tuning must first be set on C.W. as already described in para. 26. The transmitter must always be run at full power when operating on telephony or modulated continuous wave.

45. For telephony service the knob marked TEL/M.C.W. C.W. is turned to TEL and after about half-a-minute to allow the valves to warm up, the modulator unit is ready for operation.

46. The power amplifier grid bias control R_{85} on the right-hand bay must first be adjusted so that the total anode current of the two valves is 0.45 amp., which corresponds with a grid bias of approximately 200 volts. The knob marked MODULATION CONTROL should then be set so that when speaking into the microphone at a convenient level, the modulation monitor meter M_2 reads on an average 80 per cent modulation.

47. For use on M.C.W., the grid bias must first be set to give the current of 0.45 amp., with the switch S_{1A} to S_{1J} at TEL. as described above. When this has been done, the switch can be turned to M.C.W. and keying can then be carried out in the same way as for C.W.

48. When the transmitter is issued for service, the controls on the modulator unit are set correctly to give 100 per cent modulation frequency of 1,000 cycles per second for the tone. The modulation monitor should read approximately 100 per cent modulation when the key is down.

49. If it is required to readjust the modulation controls, a cathode-ray oscillograph will be required which is coupled to the aerial circuit to show a picture of the carrier. When the output circuit has been tuned on C.W. it is necessary to find the correct combination of grid bias, drive and audio frequency voltage to give 100 per cent modulation without appreciable distortion. The following guide should be observed:—

- (i) The grid bias should be about 190 to 200 volts.
- (ii) The anode current without modulation should not exceed 0.45 amp.
- (iii) The control SET ZERO MODULATION MONITOR should be adjusted so that the meter M_2 reads one small division with no modulation.
- (iv) The control SET GAIN MODULATION MONITOR should be adjusted so that the meter reads 100 per cent when the modulation is 100 per cent as observed on the oscillograph.

Crystal drive operation

50. To operate the transmitter on the crystal oscillator it should be switched on and all wave-change switches set to the correct band and the crystal selector switch to the correct crystal frequency. The screened lead is then pushed home into the output socket from the crystal unit and into the crystal input socket in Unit E. Some crystals will oscillate at several frequencies, only one of which is correct. To ensure that the correct frequency is selected, the transmitter should be tuned on the master oscillator to the frequency required and then the connection from the crystal unit plugged in. Oscillation of the crystal is indicated by a large dip in plate current. The condenser should be set slightly away, in a counter-clockwise direction, from the position at which oscillations suddenly cease.

51. The anode current of the crystal oscillator should be between 4 and 6.5 milliamps and that of the buffer amplifier about 7 milliamps.

52. When the crystal is operating at the correct frequency, the main tuning dial on the master oscillator should be adjusted for maximum power amplifier grid current. The currents in the grid and anode of the driver valve should be approximately the same as for normal operation without crystal drive. With the exception of the points mentioned in the foregoing paragraphs, operation of the transmitter with crystal drive is exactly the same as when employing the normal inductance capacity oscillator.

Tuning—General

53. The final position selected for the fine tuning controls on all bands must correspond with the maximum dip in anode current, which must be within the limits of 1 and 1.2 amps. for 2 kilowatts output into the aerial.

54. Although the frequency bands on the oscillator are divided into four definite bands of 110 to 150, 150 to 300, 300 to 600, 600 to 1,200 kc/s., it may be found that the output circuit has to be set to a different band to that of the oscillator. For example, on 700 kc/s the oscillator would be set to SHORT WAVE but the output circuit might have to be adjusted as for MEDIUM WAVE.

Harmonics

55. It is possible to obtain false tuning positions in the adjustment of the output circuit by setting it to the second, third, etc. harmonic frequency. The correct setting can always be determined, as the anode current dip is greatest at the correct setting, and the correct setting corresponds to the maximum value of inductance and capacity in the circuit.

T.1259 COMPONENT REFERENCES

The numbers in the first column relate to the annotations on the circuit diagrams and photographs. Those in the second column are the numbers signwritten on the actual components which can be located by cross reference.

MODULATOR UNIT "D"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
1	95	25 k.	1	148	2	V ₁	85
2	197	75 k.	2	98	.05	V ₂	184
3	83	50 k.	3	300	25	V ₃	55
4	97	5 k.	4	301	.06	V ₄	182
5	99	100 k.	5	302	.03	V ₅	109
6	86	20 k.	6	303	.015	V ₆	183
7	198	100 k.	7	81	2	T ₁	978
8	201	100 k.	8	80	.005	T ₂	117
9	106	5 k.	9	84	0.25	L ₁	128
10	203	100 k.	10	63	50	J ₁	138
11	67	100	11	75	.01	M ₁	33
12	66	1 M	12	206	2	M ₂	36
13	70	250	13	78	0.1	S _{1A-J}	87
14	497	5 k.				S ₂	286
15	496	5 k.				S ₃	
16	297	2 k.					
17	422	2 k.					
18	200	25 k.					
19	76	150 k.					
20	77	50 k.					
21	145	500					
22	146	1 k.					
23	108	2 M					
24	104	1 M					
25	82	30 k.					
26	143	25					
27	149	30 k.					
28	150	9 k.					

MASTER OSCILLATOR "E"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
29	89	25 k.	14	179	0.1	V ₇	51
30	88	50 k.	15	15	2	V ₈	185
31	154	1 k.	16	130	8	V ₉	121
32	96	250 k.	17	754	25 μF	L ₂	11
33	18		18	755	25 μF	L ₃	12
34	10	6 k.	19	756	25 μF	L ₄	113
35	160	1 k.	20	277	450 μF	L ₅	19
36	178	1 k.	21	410	.006	L ₆	20
37	123	25 k.	22	157	0.7	L ₇	21
38	90	600	23	177	0.1	L ₈	22
39	16	2 M	24	156	0.1	L ₉	23
40	158	250	25	4	15-45 μF	L ₁₀	24
41	298	6 k.	26	5		J ₂	135
42	310	6 k.	27	6		J ₃	18
43	25	10 k.	28	278	450 μF	S _{4A}	294
44	27	50	29	105	.25	S _{4B}	294A
45	26	50	30	7		S ₅	290
46	113	4 k.	31	8	4-21 μF	S _{6A}	295
47	133	10 k.	32	9		S _{6B}	295A
			33	279	450 μF	S ₇	292
			34	285	450 μF	S _{8A}	296
			35	167	.0001	S _{8B}	296A
			36	112	2	S ₉	287
			37	94	.25	S ₁₀	288
			38	169		M ₃	38
			39	17	3 μF	M ₄	45
			40	166	.0001	M ₅	41
			41	169		REL.1	299
			42	175	.001	REL.2	134
			43	169		N ₁	64
			44	59	0.5	N ₂	64

POWER AMPLIFIER "F"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
48	31	10	45	191	2	V ₁₀	53
49	102	50	46	60	2	V ₁₁	54
50	491	100	47	174	0.02	L ₁₁	52
51	492	100	48	172	0.1	L ₁₂	420
52	103	50	49	232	0.1	L ₁₃	753
53	40	10	50	46	1	S _{11A}	419
			51	233	0.1	S _{11B}	419
			52	234	0.1	S _{12A}	752
			53	107	—	S _{12B}	752
			54	60	2	S _{13A}	751
			55	176	—	S _{13B}	751
			56	750	0.004	S _{13C}	751
						M ₆	42
						M ₇	50
						M ₈	140
						M ₉	49
						REL.3	274
						REL.4	275

CRYSTAL UNIT "C"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
54	403	10 k.	57	331	15-45 μF	V ₁₂	321
55	407	1 k.	58	332		V ₁₃	322
56	409	2 k.	59	333		L ₁₅	334
57	404	2 M	60	395	0.1	L ₁₆	335
58	405	250	61	397	0.25	L ₁₇	336
59	406	25 k.	62	401	0.1	L ₁₈	337
60	408	250	63	411	3 μF	L ₁₉	338
			64	396	0.1	L ₂₀	339
			65	320		S _{15A}	325
			66	413	30 μF	S _{15B}	325
			67	398	5 μF	S ₁₆	326
			68	412	100 μF	M ₁₀	324
			69	400	0.1	M ₁₁	323
			70	399	0.1	J ₄	327
			71	320		X ₁	
			72	402	0.1	X ₂	

POWER CONTROL UNIT "C"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
61	353	400	73	237	8	V ₁₄	163
62	351	400	74	238	8	V ₁₅	424
63	410	3 k.	75	239	8	V ₁₆	218
64	219	6	76	426	8	V ₁₇	213
65	162	50 k.	77	498	8	S ₁₇	352
66	164	5 k.	78	305	8	S ₁₈	350
68	304	1 k.	79	217	8	S ₁₉	820
69	216	500 k.	80	147	0.1	S ₂₀	223
70	215	1 M				S ₂₁	220
						REL.5	224
						REL.6	230
						REL.7	231
						REL.8	312
						REL.9	311
						REL.10	265
						T ₃	763
						L ₂₁	62
						L ₂₂	425
						M ₁₂	34
						M ₁₃	236
						M ₁₄	47
						F ₁	284
						F ₂	428
						W ₁	14
						W ₂	58

TRANSFORMER UNIT

Ref.	Component
T ₄	110
T ₅	764
T ₆	822
T ₇	118
L ₂₃	823
L ₂₄	821
S _{22A-E}	124
S ₂₃	306

RECTIFIER UNIT "B"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
71	151	50	81	192	4	V ₁₈	57
72	228	0.25	82	61	8	V ₁₉	187
73	229	0.25	83	190	4	V ₂₀	188
74	244	6 x 7.5 k.	84	74	.2	V ₂₁	189
75	—	—				V ₂₂	56
76	165	500				V ₂₃	186
77	155	1 k.				L ₂₅	761
78	241	7.5 k.				L ₂₆	762
	243					L ₂₇	759
79						L ₂₈	760
						L ₂₉	757
						L ₃₀	758
						S ₂₄	222
						S ₂₅	641
						M ₁₆	65
						M ₁₇	114
						M ₁₈	115
						M ₁₉	37
						M ₂₀	28
						M ₂₁	43
						M ₂₂	44
						T ₈	120
						T ₉	173
						T ₁₀	208
						T ₁₁	73
						T ₁₂	72
						T ₁₃	209
						F ₃	283
						F ₄	282
						F ₅	281
						F ₆	280

TRANSMITTER T.1302

General description

56. The transmitter T.1302 is fundamentally the same as the type T.1259. The output rating is the same, viz. 2 kW. for C.W. operation and 500 watts on telephony and M.C.W. The frequency range, however, is different and a photo-cell anode dissipation meter for the two power amplifier valves is incorporated. A view of the T.1302 is given in fig. 16.

57. The frequency range is divided into five bands as given below:—

- (i) 150 kc/s to 300 kc/s
- (ii) 300 kc/s to 600 kc/s
- (iii) 600 kc/s to 1,400 kc/s
- (iv) 1,400 to 3,000 kc/s
- (v) 3,000 kc/s to 6,000 kc/s

58. Radio-frequency excitation can be obtained from a crystal oscillator or a stabilised oscillator on frequencies between 1,400 kc/s and 6,000 kc/s, or by an external supply through a 100-ohm line on frequencies between 150 kc/s and 6,000 kc/s.

59. The circuit of the T.1302 transmitter is given in fig. 17 and it will be seen that the chief differences between this and the T.1259 circuit are in the master oscillator and power amplifier and the inclusion of the photo cell anode dissipation meter. The modulator circuit is exactly the same.

Master oscillator

60. The circuit of the master oscillator employs a pentode oscillator valve V_7 , followed by a buffer doubler V_8 and a pair of final driver valves V_9 and V_{9A} . There are three tuned circuits and the tuning arrangements are such as to allow single-knob tuning of the oscillator and buffer stages. The driver stage is tuned separately. The master oscillator valve and the buffer doubler valve, together with the various decoupling resistances and condensers are mounted in a separate tank-shaped sub-assembly. The temperature compensated coils used for the master oscillator are also mounted in this tank. The tuning band for the master oscillator is covered in two stages, i.e. (i) 1,400 kc/s to 3,000 kc/s. (ii) 3,000 kc/s to 6,000 kc/s.

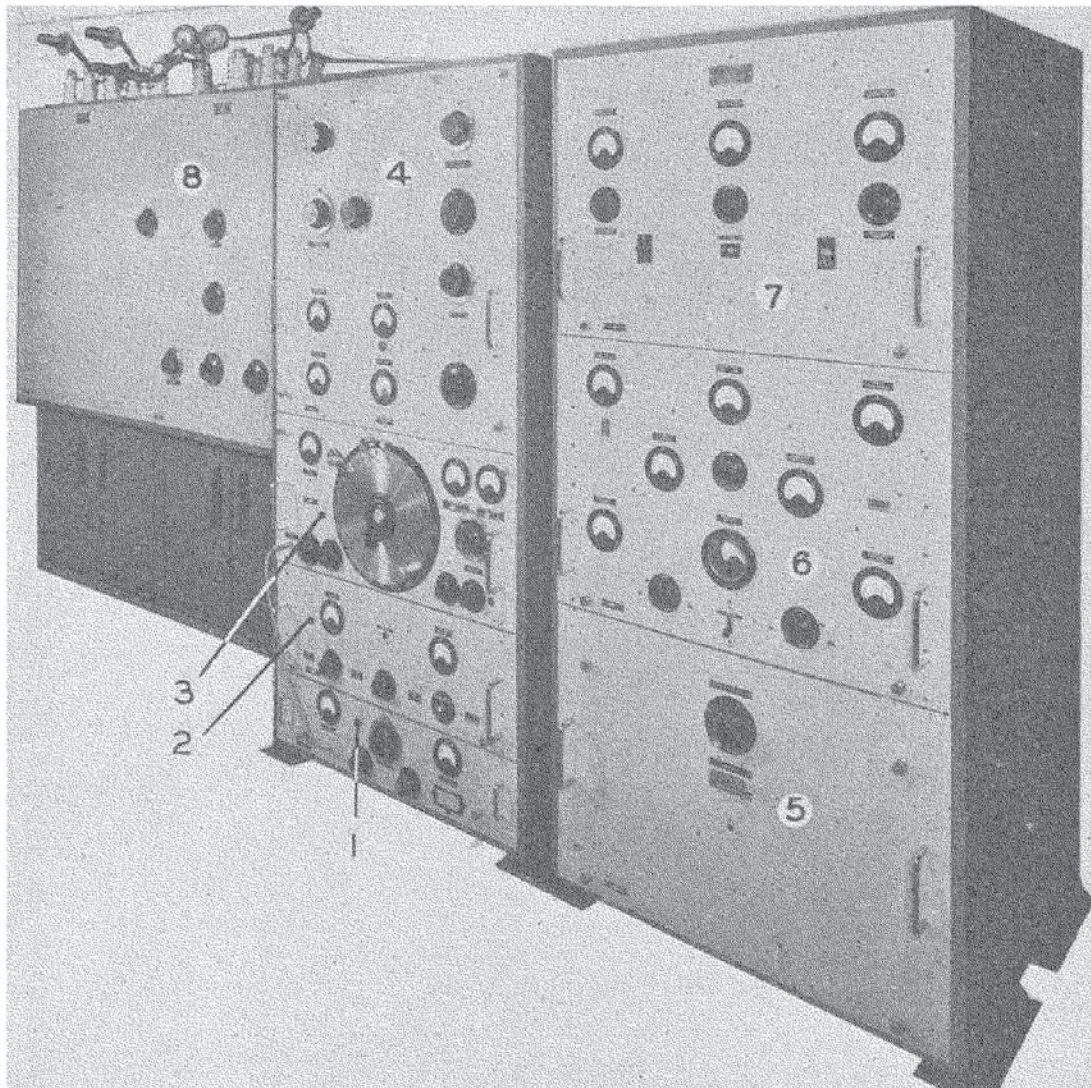


FIG. 16. TRANSMITTER T.1302

61. For line excitation the signal is fed into the grid of the buffer valve V_8 at fundamental frequencies. The total frequency spread is covered in the five bands given in para. 57. The level of this supply is controlled by an attenuator calibrated in 2 db. steps of 18 db.

62. The output from the buffer doubler valve V_8 is fed into the grids of a pair of driver valves V_9 and V_{9A} connected in parallel, and the output of the choke-fed tuned anode circuit is used to drive the grids of the two parallel connected power amplifiers V_{10} and V_{11} . The driver valves V_9 and V_{9A} are supplied with a separate anode supply, thus preventing the oscillator supply being subjected to voltage surges when the driver stage is keyed. For use on telephony and M.C.W. transmissions, modulation is effected on the anodes of the driver valves V_9 and V_{9A} , and the two power amplifiers V_{10} and V_{11} are arranged to operate as linear class-B R.F. amplifiers.

Power amplifier

63. On 1,400 kc/s to 6000 kc/s a vertical aerial is used. The power amplifiers feed the tank circuit which consists of a tapped inductance L_{40} tuned by an oil-dielectric condenser C_{02} . This circuit is inductively coupled to the aerial circuit which consists of an inductance L_{41} tuned by an air-dielectric condenser C_{73} . A tap switch S_{23} enables the aerial to be connected to any one of fifteen positions on this coil.

64. On the 600 kc/s to 1,400 kc/s band, a double-top T aerial is used. The aerial is inductive and is tuned by means of a variable air-dielectric condenser C_{73} , and a tapped coil S_{38} in the separate coil box, and the oil filled tank condenser C_{63} , all in series, the feed from the output valves being applied across the oil condenser.

65. On the 300 kc/s to 600 kc/s band, where the aerial impedance changes from capacitive to resistive, the arrangements are fundamentally the same except for the omission of the air condenser. Additional capacity can be switched in in three steps in parallel with the oil condenser C_{63} . The total capacity thus formed constitutes the principal control of loading and the tapping switch S_{40} the principal control of tuning.

66. In the 150 kc/s to 300 kc/s band, the fundamental circuit remains as before, but a tapped aerial loading coil is connected in series with the above-mentioned components.

67. The power amplifier chassis is fitted with overload cutouts for the screens of the power amplifier valves, and meters M_8 , M_6 , M_7 on the panel of the unit show the power amplifier grid current, screen current and anode current respectively.

Aerial switching

68. Four aerial switches are provided on the top of the loading coil boxes. That nearest the transmitter is the band selection switch. It has five positions and is used in conjunction with the band selection switches on the master oscillator unit, the power amplifier unit and the medium and long-wave coil unit.

69. The switch to the left of the 5-position band selection switch is spring-loaded and when closed it shunts a 0-5 thermoammeter in series with the aerial. This switch is held open for reading aerial currents up to 5 amps. Still further to the left are the two aerial selection switches which connect the aeriels to the transmitter or to the radial earth when they are not in use.

Power supply unit

70. The power supply unit for the T.1302 transmitter is the same as that for the T.1259.

Photo-cell anode dissipation meter

71. The anode dissipation meter is a safety device which makes it impossible to run the transmitter with the anodes of the power amplifier valves dissipating a wattage in excess of the rated value of 450 watts.

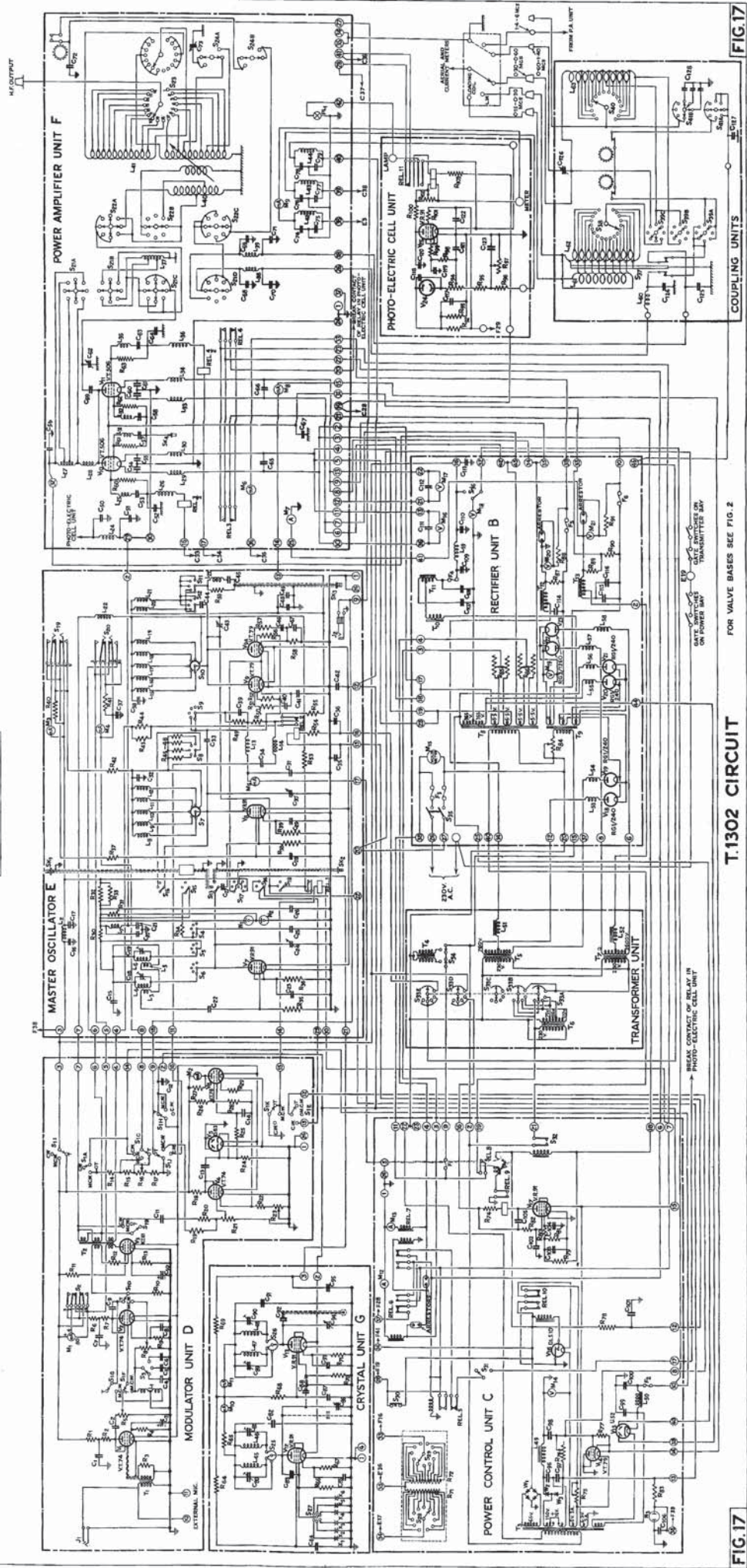
72. The unit consists of a photo-cell V_{24} type mounted between the two power amplifier valves V_{10} and V_{11} and screened in such a manner that the only light falling on the cell is that which is emitted from the hot power amplifier anodes. The output from the photo-cell is fed through a screened lead to an amplifier consisting of a V_{25} type valve which is totally screened in a metal box and is situated in the power amplifier unit. The output of this amplifier feeds a relay controlling the transmitter cutout relays, a warning lamp, optional A.C. buzzer and meter which are fitted on the front panel.

73. The meter is calibrated directly in watts. The warning lamp below the meter lights just before the power amplifier anodes reach the temperature that will cause the photo-cell unit to operate the safety cutout relays. The amplifier has three preset controls—one for gain R_{94} , one for bias R_{17} , and the third for sensitivity control R_{102} . Fig. 18 shows the interconnections of the units.

OPERATION—T.1302 TRANSMITTER

74. The operation of the T.1302 transmitter is, in most respects, similar to the T.1259, and the general instructions given for that apply to this equipment also and reference should be made to them. This transmitter has been designed to operate as a linear amplifier with a peak output of approximately 1.5 kilowatts between 0.15 Mc/s and 6 Mc/s.

75. In addition, a master oscillator is fitted which is tunable over the range between 1.4 Mc/s and 6 Mc/s. Provision is made for the rapid selection of spot frequencies on the master oscillator by a series of slots situated behind the plunger on the master oscillator dial into which the plunger may be pressed for purposes of location.



T.1302 CIRCUIT

FIG. 17

PP2116 M 1161 343 13000 C & P Gp.959 (4)

76. The transmitter may be fed from any 50-cycle supply at voltages between the limits of 190 and 260 volts, or from any 230-volt supply at frequencies from 50 to 100 cycles. The load is approximately 5 kW. for C.W. telegraphy operation.

77. The transmitter has been designed to operate with dual aerial systems. For the first three bands it has been designed to feed an aerial of about $0.001 \mu\text{F}$ capacity and a resistance of 4 ohms or more and the recommended aerial is a twin T (with spreaders of approximately 10 ft.) 275 ft. long and 150 ft. high.

78. For the two highest frequency bands a single vertical aerial is recommended, approximately 70 ft. high, consisting of a single wire, or several wires in the form of a cage approximately 8 in. to 10 in. in diameter. A suitable earth system consists of 30 equally spaced radial 14 gauge copper wires, each 150 ft. long, buried about 9 in. deep. The arrangement is shown in fig. 19.

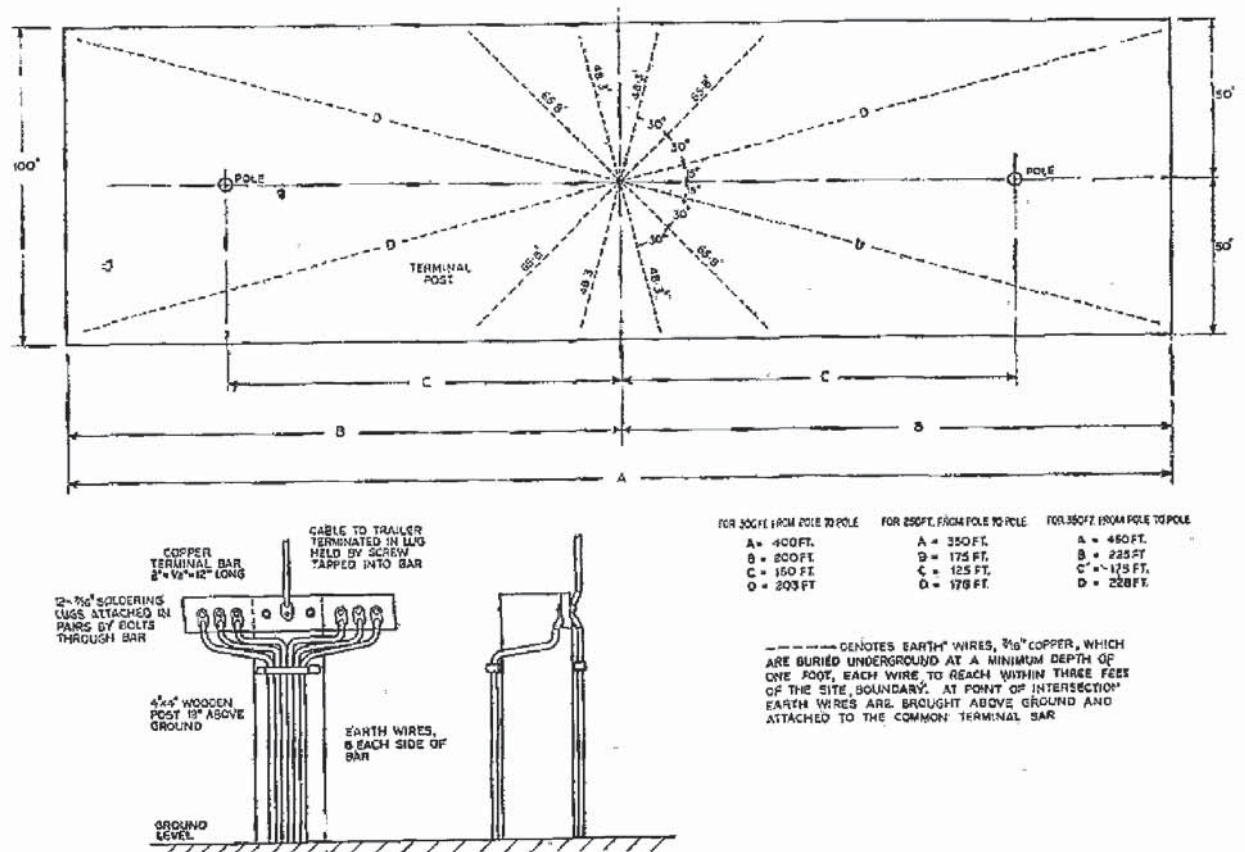


FIG. 19.—EARTH SYSTEM

79. The preliminary operating instructions relating to the T.1259 transmitter are applicable to the T.1302 also. The switch on the master oscillator unit labelled OSCILLATOR (1.4 to 6 Mc/s only) LINE (for linear amplifier service over the full range) CRYSTAL (1.4 to 6 Mc/s only) must be set in accordance with the type of operation required.

80. Nine band change switches are provided, i.e. one on the master oscillator unit S_4 to S_{12} , three on the power amplifier unit, S_{22} , S_{21} , S_{24} , two on the low-frequency coil box panel S_{39} , S_{37} , and three on the top of the low-frequency coil box. Each must be set to the band required. It should be noted, however, that the point in the frequency range at which the output circuit switches are changed may not be quite the same as the point where the oscillator switch is changed.

81. The two switches on the extreme left and on top of the long-wave coil box are employed to select the appropriate aerial. The switch controlling the aerial not in actual use must be set to EARTH and both aerials should be earthed when the transmitter is not in use. Tuning switches and power control switch, but not the band change switches, may be operated with the transmitter switched on, even with the key down, up to a quarter power.

82. Controls labelled CATHODE CURRENT-EQUALISERS are provided to equalise the heating of the anodes of the two power amplifier valves. This must be such that the cherry red spot in the middle of the anodes does not extend more than half way to the backs and fronts, which corresponds with the maximum permissible dissipation. They should both be turned clockwise as far as possible, the limit being set by the fact that the screen current must not exceed 200 mA on full power.

83. The meter M_3 , fitted on the power amplifier panel, indicates the dissipation of the power amplifier valves which must not be allowed to exceed 450 watts. If this value is exceeded, the photo-electric safety device will automatically switch the transmitter off and it will be necessary to push the button marked PUSH TO RESET TRIP to start it up again. A delay of $2\frac{1}{2}$ seconds will occur before the transmitter restarts.

Tuning

84. C.W. 1.4 to 6 Mc/s.—Set the master oscillator wave change switches to the frequency band required, and set the main large dial in the centre of the master oscillator unit to the frequency at which transmission is required. The key should then be pressed and the meter measuring the drive anode current will show approximately 180 mA. The dial labelled DRIVER TUNING should be turned to a position where the driver anode current falls to approximately 100 mA, and where a current of 30 to 50 mA is shown on the power amplifier grid current meter.

85. When two such tuning positions of the driver anode current meter can be found, the more clockwise of these positions *must* be used. Current should now register on the power amplifier cathode current meters on the control unit, and also on the power amplifier anode current and screen current meters. Reference should be made to fig. 20, which shows the fundamental circuit employed. It is essential that the transmitter should operate finally at full power C.W. with an anode current not exceeding 1.2 amps. and with a screen current not exceeding 200 mA; at quarter power these currents will be approximately halved.

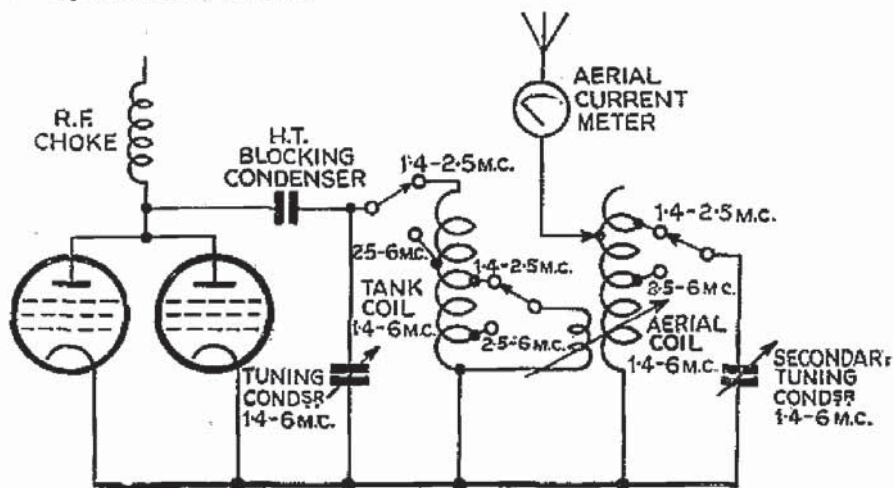


FIG. 20.—1.4 to 6 Mc/s TUNING CIRCUIT

86. C.W. 1.4 to 2.5 Mc/s.—Set the aerial coupling control to zero. When the driver tuning condenser has been correctly set, as already explained, it is necessary to set the tank coil tap switch to the band required, and to turn carefully the condenser labelled TUNING 1.4 to 6 Mc/s until the anode current has been reduced from its off-tune value of approximately 0.75 amp. to a very low value of approximately 0.1 amp. At some frequencies it will be found that there are two such positions for this control and, as in the case of the driver tuning condenser, the more clockwise position must always be used as otherwise the transmitter will operate at twice the required frequency.

87. The tank or reservoir circuit of the transmitter is now correctly tuned and the exact dial reading for maximum dip of anode current should be noted. It is next necessary to tune the aerial circuit and couple the secondary circuit to the tank circuit in order to radiate. The fundamental circuit of the aerial coupling device can be found on the same diagram as that which shows the power amplifier tank circuit. When the required frequency of operation is between approximately 1.4 and 2.5 Mc/s the aerial looks like a condenser of some 0.00017 to 0.0003 μ F with a resistance of 5 ohms or more in series with it, and the aerial is, therefore, brought into resonance by means of inductance. The approximate amount of inductance necessary is selected by means of the aerial tap switch S_{23} on the power amplifier. As the taps provided are comparatively coarse, it is necessary to operate carefully the fine tuning condenser which is labelled FINE TUNING 1.4 to 3.0 Mc/s. TUNING, 3.0 to 6 Mc/s.

88. As a guide, for the aerial with a single vertical wire it will be found that practically the whole coil will be required to tune it at 1.4 Mc/s and less of the coil will be necessary to tune to higher (and higher) frequencies up to some 2.5 to 3 Mc/s, the amount of coil included increasing as the aerial tap switch is turned clockwise from 1 to 16. The aerial coupling coil should then be turned to approximately 10 deg. and, with the key down, the aerial tap switch set to a position based approximately on the guidance given. The fine tuning condenser should be turned to see whether at any point of its travel it is possible to obtain a peak of anode current. If no such peak is observable, the aerial tap switch should be tried in various positions until it is possible to get a peak of anode current as the fine tuning condenser is rotated on either side of the position at which the anode current decreases. This condenser must be very carefully adjusted to this peak of anode current.

89. The coupling control should then be turned until the anode current is approximately 0.5 amp. If the aerial fine tuning condenser has been correctly set, it will be found that when the tank condenser is turned slightly from the position in which it was set, the anode current rises on either side of that position.

90. If, however, the position of maximum dip of anode current when the tank condenser is turned is not that which was previously noted, the operation of fine tuning the aerial circuit must be repeated until the position of maximum dip of anode current on the tank condenser dial labelled TUNING 1.4 to 6 Mc/s is the same whether there be zero coupling or some larger value of it. The actual value of anode current at maximum dip is determined by the setting of the coupling control, the current becoming greater with increase of coupling. When this position has been found, the power control switch may be raised to half power and then the anode current should be approximately 0.8 amp., and finally to full power when the anode current should be not higher than 1 to 1.2 amps.

91. On this band the aerial current to be expected will be of the order of 8 to 17 amps. at full power, and it will be found that the tuning position will correspond nearly to that position which would give maximum output current, but it is not permissible to increase the power output of the transmitter by increasing the anode current above 1.2 amps.

92. *C.W. 2.5 to 6 Mc/s.*—Between the frequencies of approximately 2.5 and 6 Mc/s the aerial changes from looking like a condenser in series with a resistance, to look like a resistance of 40 to 80 ohms at about 3 Mc/s, and then, quite rapidly changes in character to look like a resistance in series with an inductance over the range of about 3.5 to 5.5 Mc/s. At approximately 6 Mc/s it changes yet again to look like a resistance of the order of 1,000 to 3,000 ohms.

93. The operation of tuning the tank circuit over the whole of the two highest frequency bands is unchanged, except in so far as the tank coil tap must be suitably selected for the band in use, but the tuning of the aerial circuit is somewhat different on the band 2.5 to 6 Mc/s from that on the band 1.4 to 2.5 Mc/s.

94. The correct condenser tap on the aerial coil will be chosen by reference to the engraving which shows approximately the frequencies over which the two positions should be used, and it is necessary to choose a position, by means of the 17-position switch S_{23} , on the aerial coil which will permit of the aerial circuit being brought to resonance.

95. On many frequencies, more than one position will be found on the 17-position switch at which tuning can be accomplished, and any one of these positions may be used, always provided that at full power no flash-over occurs within the power amplifier. If, at any given tuning position, flash-overs at full power occur, it will generally be necessary to connect the aerial to a higher stud position on the 17-position switch, tuning then being repeated.

96. Tuning from 2.5 to 6 Mc/s will be found very similar to that between 1.4 to 2.5 Mc/s, except that the aerial will have much less effect on the tuning of this circuit and the condenser will have more effect. The procedure is identical with that for the band 1.4 to 2.5 Mc/s, that is, the coupling control is set to approximately 10 deg., and the aerial tuning condenser is set accurately to give a peak anode current at quarter power. The coupling control is then increased until the anode current is approximately 0.5 amp. and a check is made to see that this has not changed the dial reading for maximum dip of anode current on the tank condenser.

97. Tuning is correct if this is unchanged, but a re-tuning of the aerial is necessary if this is not so, until the position of maximum dip of anode current, but not the value of anode current at maximum dip, is the same whether there be zero coupling or some larger value of it. The power switch S_{33A} to E may then be turned to full power, which should raise the anode current from 0.5 to 1.2 amps. On all frequencies it is essential that the anode current does not exceed 1.2 amps. and the anode dissipation 450 watts per valve.

Crystal control—1.4 to 6 Mc/s

98. In order to bring the crystal control unit into operation the transmitter is switched on and all wave-change switches are set to the correct band and the crystal selector switch to the correct crystal frequency. The screened lead is then pushed home into the crystal input socket on the Master Oscillator Unit front panel. The service switch S_{13} to S_{18} on the master oscillator unit should be set to CRYSTAL INPUT. Most crystals will oscillate at several frequencies, only one of which is correct. To ensure that the correct frequency is chosen, it is best to tune the transmitter on the master oscillator to the frequency required, and then to switch to crystal input. Oscillation of the crystal is shown by a large dip in crystal oscillator anode current. The condenser should be set to a position slightly counter-clockwise from the place where oscillations suddenly cease.

99. The anode current of the crystal oscillator should be between 4 and 6.5 mA, and that of the buffer amplifier about 7 mA.

100. When the crystal is operating at the correct frequency, the main tuning dial on the master oscillator should be adjusted for maximum driver grid current. The driver anode tuning condenser on the master oscillator should then be tuned exactly as explained for use with ordinary master oscillator. The crystal input can only be used over the same band as the normal master oscillator, i.e. from 1.4 to 6.0 Mc/s.

101. The currents in the grid and anode of the driver valve should be approximately the same as they are for normal operation without crystal drive.

102. Apart from these changes, the operation of the transmitter is exactly the same when running on the crystal oscillator or the normal inductance capacity oscillator.

Telephony and M.C.W.—1.4 to 6 Mc/s

103. To operate on telephony the transmitter must be tuned on C.W. at full power, and the coupling adjusted so that the anode current of the power amplifiers is 0.8 amp. and the cathode current equalisers set so that both valves take the same cathode currents. The transmitter must then be set to STANDBY by means of the switch S_{20} and the service switch on the master oscillator unit set to TEL. Wait one minute for the modulator valves to warm up. The grid bias control is set as far counter-clockwise as possible. The driver tuning condenser reading must now be noted. This must then be set as far off tune as possible; then the STANDBY ON switch is set to ON. Now slowly turn the grid bias control clockwise until the power amplifier anode current is 0.1 amp. Turn both cathode current equalisers to 10. Now retune the driver condenser to the position previously noted, and the power amplifier anode current should rise to 0.04 amp., if the P.A. DRIVE TEL control, screwdriver operated from the panel of the modulator unit, is correctly set. If it is not, it may be adjusted but normally this will not be necessary, adjustment being required only when the driver or power amplifier valves are changed or when they become very aged. The level of input to the microphone must be such that the modulation monitor reads approximately 80 per cent for normal speech. A microphone gain control enables this level to be adjusted to suit the operator.

104. To tune the transmitter on M.C.W. the above adjustments must be carried out first. Then the transmitter must be set up on C.W. at full power and the coupling adjusted until the power amplifier anode current is 10 amps. and screen current 200 mA. Go over to STANDBY and set the service switch to M.C.W. Wait a minute for the modulator to warm up. The cathode current equalisers must then be turned each to 10. On pressing the morse key, the power amplifier anode current should be 0.6 amp., and the modulation 100 per cent. A control SET M.C.W. is provided to adjust this level, but it should never need moving.

105. When put into service, the controls on the modulator are set correctly to give 100 per cent modulation at a modulation frequency of 1,000 cycles per second for the M.C.W. tone. The modulation monitor M2 should read approximately 100 per cent modulation when the key is down. With the key up, a higher reading will be observed, but the meter indications have significance only when the key is down.

106. If it is required at any time to re-adjust the modulation monitor controls, a cathode-ray oscillograph will be required. This should be coupled to the aerial so as to show a picture of the carrier. The procedure is as follows:—

- (i) With the transmitter switched off, the pointer of the modulation monitor meter should be set by the adjustment provided on the meter to the extreme left-hand mark on the scale.
- (ii) Set up the transmitter as described under M.C.W. operation.
- (iii) With the key up, the control marked SET MOD. M.C.W. should be turned to zero. This corresponds to extreme counter-clockwise rotation.
- (iv) Now adjust the control marked SET ZERO MOD. MON. so that the pointer of the modulation monitor meter indicates zero percentage modulation.

- (v) The SET MOD. M.C.W. control must now be turned to half of its rotation before pressing the key. This is necessitated by the fact that the anode dissipation of the power amplifiers rises to a high value with no modulation, and this will cause the cutouts to operate. With the key down, the SET MOD. M.C.W. control should be adjusted so that the cathode-ray oscillograph shows the modulation depth to be 100 per cent.
- (vi) The SET MOD. MON. GAIN control should then be rotated until the modulation monitor meter indicates 100 per cent key down.

No further adjustments are necessary for use on telephony.

Linear amplifier operation

107. The transmitter is designed to operate as a linear amplifier, and to function on this form of service the switch S_{13} to 18 on the master oscillator unit must be turned to LINE INPUT, and a voltage at the required frequency must be fed into the transmitter from a line having a characteristic impedance of 100 ohms.

108. To obtain the full power output which the transmitter is capable of supplying, it is necessary that a voltage of approximately 4 volts R.M.S. at least be provided at all frequencies, and a pair of attenuators giving a total loss of 26 db. are fitted for use when the input voltage is higher than this value.

109. The grid bias control for the power amplifiers is inoperative on C.W. service, but is brought into use on linear amplifier operation in order that the correct linear conditions may be obtained for the output valves.

110. The following procedure should be adopted when tuning the transmitter at all frequencies:—

- (i) Set the input attenuator to infinity so that there is no signal input.
- (ii) Set the power amplifier grid bias control on the control unit panel as far counter-clockwise as possible, when the bias voltmeter should read approximately 230 volts.
- (iii) Raise the power control switch to full power and check that the anode and screen currents are zero.
- (iv) Turn the grid bias control slowly clockwise until the anode current of the power amplifiers is 0.1 amp. this will occur at approximately 200 volts.
- (v) Reduce the power control setting to one quarter power.
- (vi) Set the master oscillator main dial to the operating frequency on its own engraved scale, and then increase the input attenuator setting until on turning the driver tuning condenser a slight dip is found in the driver anode current.
- (vii) Adjust the input attenuator until the power amplifier grid current is approximately 2 mA.
- (viii) Carry out the output circuit tuning operations as described below. When these have been completed the power control may be raised to full power.

111. The maximum coupling must be less than that on C.W. service because the maximum permissible anode current is approximately 0.75 amp. for linear operation. It will also be found that the screen current tends to be lower than that when the transmitter is used on C.W. service, and the cathode current equaliser controls may be turned up as far as they will go, but then one must be reduced as far as necessary to bring the hotter of the two valves to the same temperature as the other.

112. If, however, a larger output is required from this equipment, it is possible to adjust the anode current under these conditions to 1 amp. provided that the input can be maintained either at zero or at the full value, such as would occur if the equipment were being used as an amplifier for a smaller transmitter.

113. It will be necessary when turning the transmitter as linear amplifier, and at all times when it is required to operate, to complete the key circuit, and this should be done by utilising the key normally when tuning, and screwing it down when tuning is complete and service operation is required.

114. 1.4 to 6 Mc/s.—The operation of tuning the output circuits on this range is the same as on C.W. service, and the same procedure should, therefore, be followed.

115. 0.15 to 1.4 Mc/s.—When the transmitter is required to be used as a linear amplifier on the first three frequency bands, operation is identical with that for the two high-frequency bands up to the power amplifiers. A single circuit, however, is used on these bands to tune the low-frequency aerial, and the arrangement of these changes slightly as the frequency of operation is changed from 0.15 to 1.4 Mc/s, but throughout this range the coupling to the aerial is controlled by means of the oil-filled variable condenser C_{82} of 0.004 μ F capacity, with optionally switched fixed condensers also of 0.004 μ F, by means of which any coupling capacity from anode to ground may be used, up to a maximum of 0.016 μ F. It is necessary to tune the coupling capacity with a circuit, the resultant impedance of which is inductive.

116. On all bands the final position chosen for the knob labelled FINE COUPLING 0.15-0.60 Mc/s./COUPLING 0.60-1.40 Mc/s TUNING 1.4-6.0 Mc/s, corresponds with the maximum dip in anode current, which must be between the limits of 0.8 and 0.9 amp. for $1\frac{1}{2}$ kW. output into the aerial.

117. It is possible to obtain false tuning positions in the adjustment of the output circuit by setting it to the second or third harmonic frequency. The correct setting can always be distinguished, as the correct setting corresponds to the maximum value of inductance and capacity in the circuit.

118. 0.15 to 0.30 Mc/s.—On the lowest frequency band the aerial looks like a condenser of approximately, 0.001 μ F, in series with a resistance whose value is likely to lie between 4 ohms and 10 ohms, depending upon the site, the soil, etc. It is, therefore, necessary on this band to load the aerial with inductance to tune the coupling capacity which is effectively in series with the aerial capacity. In order to put these principles into practice on the lowest frequency band, proceed as follows. (All band change switches must be correctly set as shown on the dial engravings).

- (i) Set the condenser dial marked FINE COUPLING 0.15 to 0.30 Mc/s to mid position.
- (ii) Set the switch marked LOADING CONDENSER SELECTOR to position 1.
- (iii) Set the switch marked AERIAL FINE TUNING 0.15 to 0.30 Mc/s. AERIAL TAP 0.30-1.40 Mc/s to mid position.
- (iv) Press the key and rotate the switch on the low-frequency coil box marked AERIAL TUNING 0.15-0.30 Mc/s to a position which can be judged approximately from the frequency. For instance, at 0.15 Mc/s, set it to 18, at 0.225 Mc/s, set it to 10, and at 0.30 Mc/s, set it to 1 or 2.
- (v) Swing the condenser marked FINE TUNING 0.15 to 0.30 Mc/s until the resonant point is found. This is shown by the large dip in anode current. If no dip is found, alter the setting of the AERIAL TUNING 0.15-0.30 Mc/s switch one notch up or down and swing the condenser again.
- (vi) If the anode current dips to a value of less than 0.35 amp. the loading is too light. This is increased by reducing the setting of the switch marked FINE TUNING 0.15 to 0.30 Mc/s/AERIAL TAP 0.30 to 1.4 Mc/s, by one notch and increasing the capacity to give resonance again by turning the condenser dial marked FINE COUPLING 0.15 to 0.60 Mc/s in a clockwise direction. Continue this procedure until the anode current reads 0.4 amp. When the condenser is all in at 0 deg. bring it back to 300 deg. and bring in another loading condenser by changing the switch marked LOADING CONDENSER SELECTOR from position 1 to 2, which adds a capacity equal to that by which the variable condenser is reduced when turned from 0 deg. to 300 degrees. When the fine tuning switch S_{40} is all out at position 1, return it to a high setting, and reduce the aerial tuning switch S_{33} on the low-frequency coil box one notch.

119. With the key up, switch the transmitter to full power, press the key, and check that the anode current is between 0.8 and 0.9 amp. If it is outside these limits turn to quarter power and re-adjust the loading. Check that the two anodes are at the same temperature.

120. 0.30 to 0.60 Mc/s.—Here the fundamental circuit remains the same as that from 0.15 to 0.30 Mc/s but the low-frequency coil L_{02} is not used. The only tuning coil in circuit is that used from 0.15 to 0.30 Mc/s for fine tuning.

121. At the low frequency end of this band the aerial approximately resembles a condenser of 0.0015 μ F. in series with a resistance which may vary from 5 to 12 ohms, and this gradually changes until at the higher frequency end of this band the aerial resembles a resistance of approximately 40 ohms.

122. Tuning and loading are carried out as before, but any change in the tapping position requires a larger change in the condensers, as at the high frequency end of this band they tend to form the only capacity in circuit. Note: As frequency is raised from 0.15 Mc/s upwards, the loading capacity required becomes less and less. In all other respects tuning from 0.30 to 0.60 Mc/s is identical with that from 0.15 to 0.30 Mc/s.

123. 0.60 to 1.4 Mc/s.—Here the aerial resembles a resistance in series with an inductance, and at the lower frequency end of the band both inductance and resistance are small, the latter being of the order of 40 ohms, and as the frequency increases both rise until at the high-frequency end of this band the aerial will probably resemble a resistance of some 2,000 ohms.

124. Although the circuit elements are different from those used at the lower frequencies, the fundamental circuit remains as before, except that a variable air condenser C_{73} is inserted in series with the aerial and the medium frequency tapped tuning coil. The inductance of the circuit is formed by the aerial in series with the coil and the capacity by the aerial tuning condenser on the lower frequency coil box in series with the condenser labelled COUPLING 0.60 to 1.4 Mc/s. Thus, when this latter condenser is at 300 degrees the coupling is the lowest possible. Tuning operations are:—

- (i) Set the loading condenser selector switch S_{41} to zero.
- (ii) Set the aerial tuning condenser C_{73} on the low-frequency coil box to maximum capacity, that is, 180 degrees.

- (iii) Set the tuning inductance L_{63} to position 16 and swing the condenser labelled COUPLING 0.60 to 1.4 Mc/s. If there are no signs of resonance reduce the setting of the aerial tap switch 1 notch, and swing the condenser again. Continue this procedure until resonance is found.
- (iv) If the anode current at resonance is less than 0.35 amp., the loading is too light. This is increased by reducing the aerial tap switch one notch and increasing the condenser labelled COUPLING 0.60 to 1.4 Mc/s to give resonance again. The aerial tuning condenser C_{73} should be left either at maximum or within 20 degrees of it.
- (v) If it is found that a change of one notch makes too big a change in the loading, set the aerial tap switch one notch higher and tune the circuit by means of the aerial tuning condenser 0.60 to 1.4 Mc/s. It is to be noted that if this condenser is not used at this end of the band, at or near the maximum capacity, it is liable to break down and also do serious damage to other switches in the equipment.

125. It will sometimes be found that when the frequency exceeds about 1 Mc/s it will no longer be possible to reduce the coupling to the aerial sufficiently, even though the coupling condenser be set to 300 degrees, which is minimum.

126. There is provided with the transmitter a silver-plated brass bar approximately 6 in. long. If it is required to operate at a frequency higher than the frequency at which coupling can be reduced to the required value, this bar should be inserted in the top right-hand change-over switch on the low-frequency coil box between the extreme right-hand contact, which is earth, and the one next but one which is labelled "0.6 to 1.4 Mc/s".

127. The rotary change-over arm of this same switch is then set to the position engraved "0.3 to 0.6 Mc/s" regardless of the fact that it is actually required to operate under these conditions at a higher frequency.

128. The coupling condenser C_{63} on the power amplifier should be set approximately to 280 degrees and the 17-position fine tuning coil switch S_{40} on the bottom right-hand of the low-frequency coil unit should be set to position 3.

129. It will probably be possible to find a tuning position (judged by the dip in the power amplifier anode current) at some position of the dial of the fine tuning condenser C_{106} on the low-frequency coil box. If this is obtainable the tuning should be correctly set by finally adjusting the coupling condenser C_{63} on the power amplifier to the maximum dip of anode current. If tuning is not obtainable on stud 3 of the coil switch, it will almost certainly be possible to tune in this manner on stud 2 or 4. The coupling, when operating under these conditions, is determined both by the normal coupling condenser and the fine tuning condenser in the coil box. Both these are condensers in series with the same circuit, and to maintain tuning if the tank condenser is increased in capacity, the other must be reduced in capacity to compensate for it; this will increase the aerial coupling and hence the anode current at maximum dip.

130. If, however, the coupling is already too large, that is, the anode current at maximum dip is too large, the aerial fine tuning condenser may be turned clockwise to increase its capacity and the coupling condenser on the power amplifier turned counter-clockwise to maximum dip. A suitable combination of this will be found to give the correct anode current when the transmitter is properly tuned.

131. If the single vertical aerial is in the form of a multi-wire cage, it will be found that this aerial can be tuned to a frequency considerably lower than 1.4 Mc/s, probably as low as 1.1 Mc/s, and this may, therefore, be used alternatively to the above special form of tuning over this narrow band.

PRECAUTIONS AND MAINTENANCE

132. Full protection is afforded the operator of the transmitter against coming into contact with any parts at which there is high voltage dangerous to life, with the exception of the aerial change-over switch and the wires leading to it.

133. When in operation, immediately any one of the rear gates of the transmitter is opened, the transmitter is automatically closed down but the grid bias circuit and parts of the main wiring will still be alive.

134. Arrester lamps are fitted between the low potential end of the two high tension voltmeters and chassis to ensure that in the event of either becoming open circuited, the movement of the meter cannot become live by an amount capable of breaking down the insulation of the meter housing. In addition, in the event of either cathode current meter becoming open circuited, further neon lamps operate to pass the cathode current and in addition pull out one of the cathode current overload trips.

135. In the event of any cut-out being operated, the transmitter can be restarted by pressing the knob PUSH TO RESET TRIP, the transmitter being ready for service after a delay of two-and-a-half seconds.

136. The main fuses F_3 , the main H.T. fuse F_6 , and the screen fuses F_5 , will be found at the back of the right-hand bay (as seen from the front) on the middle chassis, which is accessible by opening the rear gates.

Adjustment of anode watt meter

137. To adjust the anode watt meter, the transmitter should be set at quarter power on the C.W. OSCILLATOR tuning dial at say 2 Mc/s. and the tank condenser should be set to zero degrees with all switches set suitably for 2 Mc/s. Looking at the photo-cell amplifier from the rear, there will be seen to be three screwdriver operated controls, two facing the operator and one on the top, at the back, accessible through the top cover plate. This last control and the left-hand one should be set as far counter-clockwise as they will go.

138. The key should now be pressed and the driver tuning condenser C_{13} should be tuned by power amplifier grid current in the usual way, and it will be found that the anode current under these conditions will be approximately 0.75 to 0.9 amp., and the H.T. voltage about 1,200 volts.

139. The watts dissipation per valve is obtained by multiplying the H.T. voltage by half the anode current. Assuming the H.T. voltage to be 1,200 volts, to obtain 450 watts per valve, the total anode current should be 0.75 amp. This may be accurately adjusted by means of the driver tuning condenser C_{13} . If the H.T. voltage under these conditions is different from 1,200 volts, the anode current must be adjusted until both multiplied together and divided by 2 come to 450 watts.

140. With the key up, the right-hand photo-cell control (as viewed from the rear of the transmitter) should then be turned until the anode dissipation meter M_2 on the front panel reads approximately $\frac{1}{8}$ in. above the 450-watt mark. With the key down, the top rear control should then be turned very slowly clockwise. When the meter needle has nearly reached the 450-watt mark, the front red lamp should light to show, when operating the transmitter normally, that the maximum dissipation is nearly reached. As the control is still further slowly turned, the transmitter will cut out, and the control should be left just at the position at which the transmitter cuts out and no further: this will ensure that the transmitter is protected against running with the anodes dissipating more than 460 watts. The rear control, which adjusts the sensitivity of the cut-out relay, is now correctly set, but the other two controls facing the operator have still to be adjusted. To adjust these the following simple trial and error method must be adopted:—

- (i) Restart the transmitter by pushing the PUSH TO RESET TRIP S_{10} button.
- (ii) Set the transmitter up as already described so that the product of H.T. voltage and half the total anode current is 450 watts. Set the left-hand control which controls the photo-electric cell amplifier gain approximately half-way between the two extreme positions and, with the key up, turn the right-hand control until the dissipation meter reads zero watts, which is the line immediately to the right of the extreme left-hand mechanical zero of the meter. The key should then be pressed and the dissipation meter needle will rise slowly as the anode temperature increases. This rise must be such that the meter shows 450 watts which is the dissipation per valve under these conditions.
- (iii) If the meter does not rise far enough, the key should be released, the left-hand gain control turned a little clockwise, and the right-hand control turned the necessary amount to make the meter read zero watts again. The key should then be pressed and the final position of the dissipation meter noted. If this is low 450 watts, the adjustment is correct. If it is less than 450 watts the above procedure must be repeated, and if it is more than 450 watts, that is, if the transmitter cuts out, the reverse procedure should be followed, that is, the left-hand gain control should be turned counter-clockwise and the right-hand control turned the necessary amount to re-establish zero with the key up, etc. until the correct meter reading shows after the key has been down for a period of approximately one minute.

141. The dissipation meter is then correctly set. It must be noted that this setting will not hold when the power amplifier valves have been changed, or when a new photo-electric cell or valve V_{25} has been fitted, owing to variations in the clarity of the glass of the power amplifiers and variations in the amplification given by the photo-cell amplifier valve. Exactly the same procedure may, however, be followed to re-set the photo-cell controls.

142. There is a tendency for air bubbles to enter the spaces between the vanes of the tank condenser C_{107} after the equipment has been moved and this occurrence can result in a breakdown. The bubbles can be dispersed by turning the condenser rapidly from end to end of the scale several times. This should always be done after the transmitter has been moved and before it is switched on.

143. If metal-sheathed cable is used for connecting the T.1259 transmitter to the mains, it is essential that the sheathing should not come into contact with any part of the chassis of the equipment, otherwise the aerial current meter will be short circuited.

T.1302 COMPONENT REFERENCES

The numbers in the first column relate to the annotations on the circuit diagrams and photographs. Those in the second column are the numbers signwritten on the actual components which can be located by cross reference.

MODULATOR UNIT "D"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
1	95	25 k.	1	148	2	V ₁	85
2	197	75 k.	2	98	0.05	V ₂	184
3	83	50 k.	3	300	25	V ₃	55
4	97	5 k.	4	301	0.06	V ₄	182
5	99	100 k.	5	302	0.03	V ₅	109
6	86	20 k.	6	303	0.15	V ₆	183
7	198	100 k.	7	81	2	T ₁	111
8	201	100 k.	8	80	0.005	T ₂	117
9	106	5 k.	9	84	0.25	L ₁	128
10	203	100 k.	10	63	50	J ₁	138
11	67	100	11	75	0.01	M ₁	33
12	66	1 M	12	714	0.2	M ₂	36
13	70	250	13	206	2	S _{1A-K}	87
14	711	5 k.	14	78	0.1	S ₂	286
15	710	1 k.				S ₃	—
16	297	2 k.					
17	712	2 k.					
18	200	25 k.					
19	708	250 k.					
20	709	500 k.					
21	77	50 k.					
22	145	500					
23	146	1 k.					
24	108	2 M					
25	104	1 M					
26	82	30 k.					
27	143	50					
28	149	30 k.					
29	150	9 k.					

MASTER OSCILLATOR "E"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
30	573	1.5 k.	15	537	0.5	V ₇	51
31	96	250 k.	16	570	0.2	V ₈	185
32	10	6 k.	17	569	0.2	V ₉	121
33	48	6 k.	18	540	100 μF	V _{9a}	602
34	154	1 k.	19	541	100 μF	L ₂	534
35	571	1 M	20	564	0.1	L ₃	516
36	90	600	21	565	0.1	L ₄	515
37	160	1 k.	22	538	50 μF	L ₅	518
38	580	100 k.	23	539	0.1	L ₆	517
39	158	250	24	169/1	—	L ₇	529
40	—	—	25	157	0.1	L ₈	519
41	—	—	26	15	2	L ₉	520
42	178	1 k.	27	546	50 μF	L ₁₀	521
43	592	25 k.	28	156	0.1	L ₁₁	522
44	591	25 k.	29	166	0.1	L ₁₂	523
45	584	7.5 k.	30	169/2	—	L ₁₃	530
46	585	12.5 k.	31	105	0.25	L ₁₄	531
47	586	10 k.	32	550	0.25	L ₁₅	524
48	587	20 k.	33	552	0.0005	L ₁₆	525
49	589	5 k.	34	531	—	L ₁₇	526
50	590	100 k.	35	566	0.1	L ₁₈	527
51	27	50	36	567	0.1	L ₁₉	528
52	26	50	37	130	8	L ₂₀	532
53	582	10 k.	38	554	0.005	L ₂₁	535
54	588	1 k.	39	553	0.01	L ₂₂	533
55	593	25 k.	40	556	0.01	L ₂₃	536
56	597	50	41	558	0.25	J ₂	135
57	595	50	42	568	0.2	S ₁	500
58	598	1 k.	43	544	—	S ₂	501
59	536	—	44	560	—	S ₃	502
			45	536	—	S ₄	503
			46	557	0.01	S ₅	504
			47	559	0.25	S ₆	505
			48	562	0.2	S ₇	506
			49	561	8	S ₈	507
						S ₉	508
						S ₁₀	509
						S ₁₁	510
						S ₁₂	511
						S ₁₃	512
						S ₁₄	513
						S ₁₅	514
						S ₁₆	287
						S ₁₇	288
						S ₁₈	38
						S ₁₉	606
						S ₂₀	45
						M ₁	607
						M ₂	134
						REL.1	64
						REL.2	64
						N ₁	473
						N ₂	612
						SK.1	613
						SK.2	
						SK.3	

POWER AMPLIFIER "F"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	No.
60	615	—	50	769	0.1	V ₁₀	53
61	617	—	51	770	0.1	V ₁₁	54
62	618	—	52	60	2	L ₂₁	73
63	616	—	53	615	—	L ₂₅	15
			54	633	0.2	L ₂₈	19
			55	634	0.2	L ₂₇	29
			56	191	2	L ₂₈	28
			57	617	—	L ₂₉	24
			58	618	—	L ₃₀	25
			59	174	—	L ₃₁	17
			60	635	0.2	L ₃₂	18
			61	636	0.2	L ₃₃	26
			62	107	—	L ₃₄	27
			63	616	—	L ₃₅	16
			64	60	2	L ₃₆	20
			65	638	0.2	L ₃₇	30
			66	637	0.2	L ₃₈	71
			67	46	1	L ₃₉	72
			68	765	—	L ₄₀	31
			69	767	—	L ₄₁	32
			70	766	—	L ₄₂	21
			71	768	—	L ₄₃	22
			72	645	0.2	L ₄₄	23
			73	176	—	S _{21A-D}	47
			74	639	0.2	S _{22A-C}	46
			75	640	0.2	S ₂₃	19
			76	641	0.2	S _{24A&B}	48
			77	642	0.2	M ₆	52
			78	643	0.2	M ₇	40
			79	644	0.2	M ₈	51
						M ₉	50
						REL.3	74
						REL.4	75
						PL.1	53
						SK.4	54

CRYSTAL UNIT "G"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. Z	Component No.	Value μF	Ref.	Component No.
64	680	50 k.	80	692	15-45	V ₁₂	703
65	682	2 k.	81	693	μF	V ₁₃	704
66	404	2 M	82	395	0.1	L ₁₅	696
67	684	600	83	411	3 μF	L ₁₆	697
68	687	50 k.	84	688	0.1	L ₁₇	698
69	681	2 k.	85	396	0.1	L ₁₈	699
70	685	100 k.	86	320	540 μF	S ₂₅	700
71	686	600	87	400	0.1	S ₂₆	701
			88	398	3 μF	S ₂₇	702
			89	694	15-45	M ₁₀	323
			90	695	μF	M ₁₁	324
			91	401	0.1	X ₁₋₅	C
			92	691	0.1		
			93	399	0.1		
			94	320	540 μF		
			95	689	0.1		

POWER CONTROL UNIT "C"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
72	353	400	96	237	8	V ₁₄	163
73	351	400	97	238	8	V ₁₅	424
74	410	3 k.	98	239	8	V ₁₆	218
75	219	6	99	426	0.16	V ₁₇	213
76	162	50 k.	100	427	8	S ₂₈	352
77	164	5 k.	101	305	8	S ₂₉	350
78	304	1 k.	102	719	0.2	S ₃₀	221
79	216	250 k.	103	217	8	S ₃₁	223
80	716	100 k.	104	147	0.1	S ₃₂	220
81	215	500 k.	105	717	0.2	REL.5	224
82	718	1 k.	106	721	0.1	REL.6	230
83	722	25 k.				REL.7	231
						REL.8	312
						REL.9	311
						REL.10	265
						T ₃	131
						L ₄₉	62
						L ₅₀	425
						M ₁₂	34
						M ₁₃	236
						M ₁₄	47
						F ₁	284
						F ₂	428
						W ₁	14
						W ₂	58
						W ₃	715
						N ₃	723

TRANSFORMER UNIT

Ref.	Component No.
T ₃	110
T ₅	119
T ₆	116
T ₇	118
L ₅₁	207
L ₅₂	71
S _{33A-B&E}	124
S ₃₄	308

RECTIFIER UNIT "B"

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value μF	Ref.	Component No.
84	151	50	107	192	8	V ₁₈	57
85	228	0.25	108	61	8 + 8	V ₁₉	187
86	228	0.25	109	776	0.1	V ₂₀	188
87	244	6 × 7.5 k.	110	777	0.1	V ₂₁	189
			111	706	0.1	V ₂₂	56
88	—	—	112	707	0.1	V ₂₃	186
89	155	1 k.	113	705	0.2	L ₅₃	761
90	241	7.5 k.	114	190	4	L ₅₄	762
	/2/3		115	493	2 — 1	L ₅₅	759
91	—	—	116	74	2	L ₅₆	760
						L ₅₇	757
						L ₅₈	758
						L ₅₉	775
						S ₂₅	222
						S ₃₀	641
						M ₁₅	65
						M ₁₆	114
						M ₁₇	115
						M ₁₈	37
						M ₁₉	28
						M ₂₀	43
						M ₂₁	44
						T ₈	120
						T ₉	173
						T ₁₀	208
						T ₁₁	73
						T ₁₂	72
						T ₁₃	209
						F ₃	283
						F ₄	282
						F ₅	281
						F ₆	280

PHOTO-ELECTRIC CELL UNIT

Resistances			Condensers			Miscellaneous	
Ref. R	Component No.	Value Ω	Ref. C	Component No.	Value Ω	Ref.	Component No.
92	672	350 k.	117	665	0.1	V ₂₄	662
93	671	100 k.	118	667	0.1	V ₂₄	663
94	676	500 k.	119	732	0.1	REL. 11	664
95	679	500 k.	120	669	0.002		
96	673	50 k.	121	668	0.1		
97	677	10 k.	122	670	0.1		
98	731	100	123	666	2		
99	730	100					
100	674	3 k.					
101	729	100					
102	678	10 k.					
103	675	5 k.					

COUPLING UNITS

Condensers			Miscellaneous	
Ref. C	Component No.	Value F.	Ref.	Component No.
124	659	0.1	L ₅₀	774
125	660	0.1	L ₅₁	655
126	176	1,000 μF .	L ₅₂	269
127	661	0.1	L ₅₃	272
128	415	3 × 0.004	S ₂₇	658
			S ₃₈	273
			S _{30A-C}	656
			S ₄₀	159
			S _{41A & B}	417

SECTION 2

TRANSMITTER - RECEIVERS

SECTION 2

TRANSMITTER-RECEIVERS

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Chapter 12.

December, 1938

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**TRANSMITTER - RECEIVERS
T.R.9 AND T.R.11**

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TRANSMITTER-RECEIVER T.R.9

(Stores Ref. 10A/7917)

INTRODUCTION

1. The transmitter-receiver T.R.9 consists of a two-valve radio-telephony transmitter and a six-valve receiver contained in one case. It has been designed primarily for use in single-seater fighter aeroplanes and is intended to provide two-way communication with the ground over a distance of 35 miles, and 5 miles air to air. The frequency band covered is 6,000–4,300 kc/s, and the entire power supply for both transmission and reception is derived from a dry battery and a secondary cell. As fitted in this particular type of aeroplane the instrument itself is inaccessible to the pilot but is entirely operated by him through a system of remote control.

2. A feature of the receiver is an inter-communication arrangement which can be brought into use when the apparatus is installed in two-seater aeroplanes. The overall dimensions of the instrument are approximately $19\frac{1}{2}$ in. $\times$ $13\frac{1}{4}$ in. $\times$ $9\frac{1}{2}$ in., and the weight, including valves, H.T. battery and grid bias batteries, but excluding L.T. battery and remote control, is approximately 44 lb.

3. The principal parts (the receiver unit and the transmitter unit) are housed in a case of canvas covered wood, and from the combined instrument the necessary connections and controls are extended to a convenient position in the pilot's cockpit. At this position are situated the telephones for reception, the microphone for transmission and the remote control with its three handles, operating respectively the send-receive switch, the receiver tuning condenser and the volume control of the receiver.

4. When the send-receive handle on the controller is placed in the "send" position, the aerial and earth are connected to the transmitter, the H.T. and L.T. connections and the microphone connections are made, and the telephones are connected to the transmitter side-tone device. The oscillator valve commences to generate continuous oscillations and when the microphone is spoken into these are modulated at speech frequency, through the medium of the modulator valve, and radiation takes place on a frequency determined by the value to which the transmitter inductances have previously been set, the speaker hearing at the same time his own voice in the telephones.

5. Moving the controller handle from "send" to "receive" changes the aerial and earth connections and H.T. supply from transmitter to receiver, changes the telephone connections from transmitter side-tone device to receiver output and breaks the transmitter filament circuit. (The microphone circuit is completed in both "send" and "receive" positions of the switch and only broken at the intermediate or off position.)

6. The receiver is now ready for reception. Tuning is effected by moving the "tune" handle of the controller which operates three ganged fine tuning condensers giving a variation of one or two hundred kc/s on either side of the "spot" frequency to which the receiver has previously been adjusted. Volume of sound is controlled by means of the "volume" handle on the controller, which varies the voltage applied to the screening grids of the two screen-grid valves in the receiver.

7. If the apparatus is installed in a two-seater aeroplane, and a duplicate telephone and microphone are wired to the second occupant's position, inter-communication can be carried on when the controller handle is in the "receive" position. This is made possible by the provision of a connection from the secondary of the microphone transformer, through a condenser and resistance, to the grid of the second low frequency valve in the receiver. Speech frequencies are thus impressed upon the grid-filament circuit of this valve, amplified and reproduced in both telephones in the output circuit of the last valve.

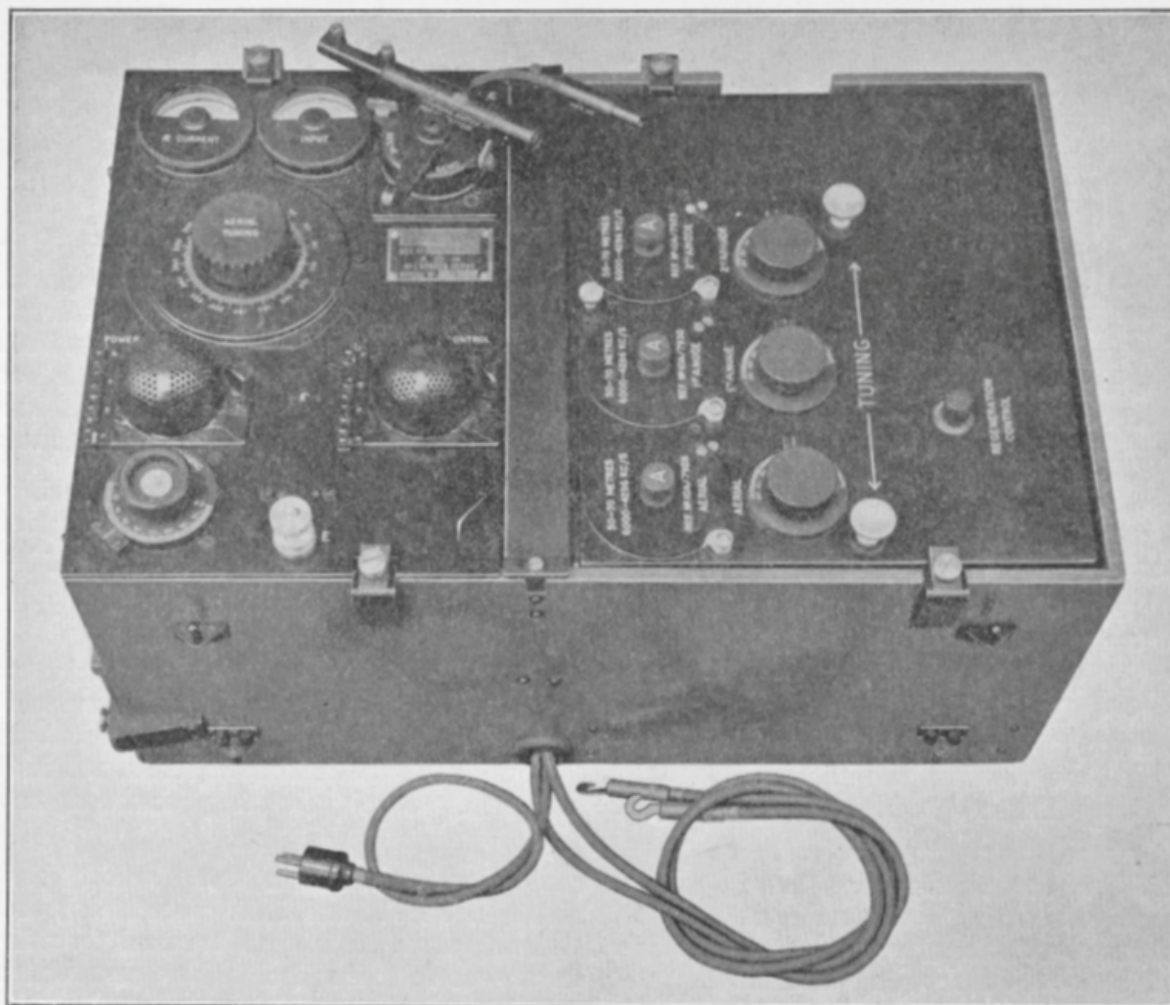


FIG. 1. Transmitter-Receiver T.R.9.

GENERAL DESCRIPTION

Transmitter

8. A theoretical diagram of the transmitter is given in fig. 3, V_1 being the oscillator valve and V_2 being the modulator valve. The aerial circuit can be traced through the ammeter A , condenser C_3 , lower portion of the inductance L_1 , condenser C_2 , filament circuit and earth. The circuit is tuned by means of a tapping S which is rotatable within the coil L_1 . The anode circuit of the oscillator valve includes the inductance L_1 , and the H.T. supply is *via* the milliammeter MA , the low frequency choke L_4 , and the R/F. choke L_3 . In the grid circuit of the oscillator valve are the tuning variometer L_2 , the grid condenser C_1 and grid leak R_1 . The grid and anode circuits are arranged for minimum inductive coupling, R/F. oscillation being maintained by virtue of the inter-electrode capacitance of the valve.

9. The modulator valve V_2 has its anode connected to the junction point of the R/F. choke L_3 and the A/F. choke L_4 , choke modulation being employed in the approved manner. The grid circuit of the modulator valve includes the secondary winding of the transformer T and a grid bias battery. Connected across the transformer secondary winding is a condenser C_4 for the purpose of obtaining the desired response characteristic from the transformer.

One side of the primary winding of the transformer is permanently connected to L.T.+, and when the transmitter is in operation the other end of the winding is connected *via* the microphone to L.T.—.

10. The transmitter incorporates a side-tone arrangement which enables the operator to hear, in his head-telephones, the speech as radiated by the transmitter. This circuit can be traced from the anode of the modulator valve through the condenser C_5 , and through the telephones to earth.

Receiver

11. A theoretical circuit diagram of the receiver is given in fig. 6. The receiver employs six valves, the first two being screen-grid R/F. These are followed by a detector, two A/F. amplifying valves, and an output valve. Three tuned circuits are employed, each circuit being

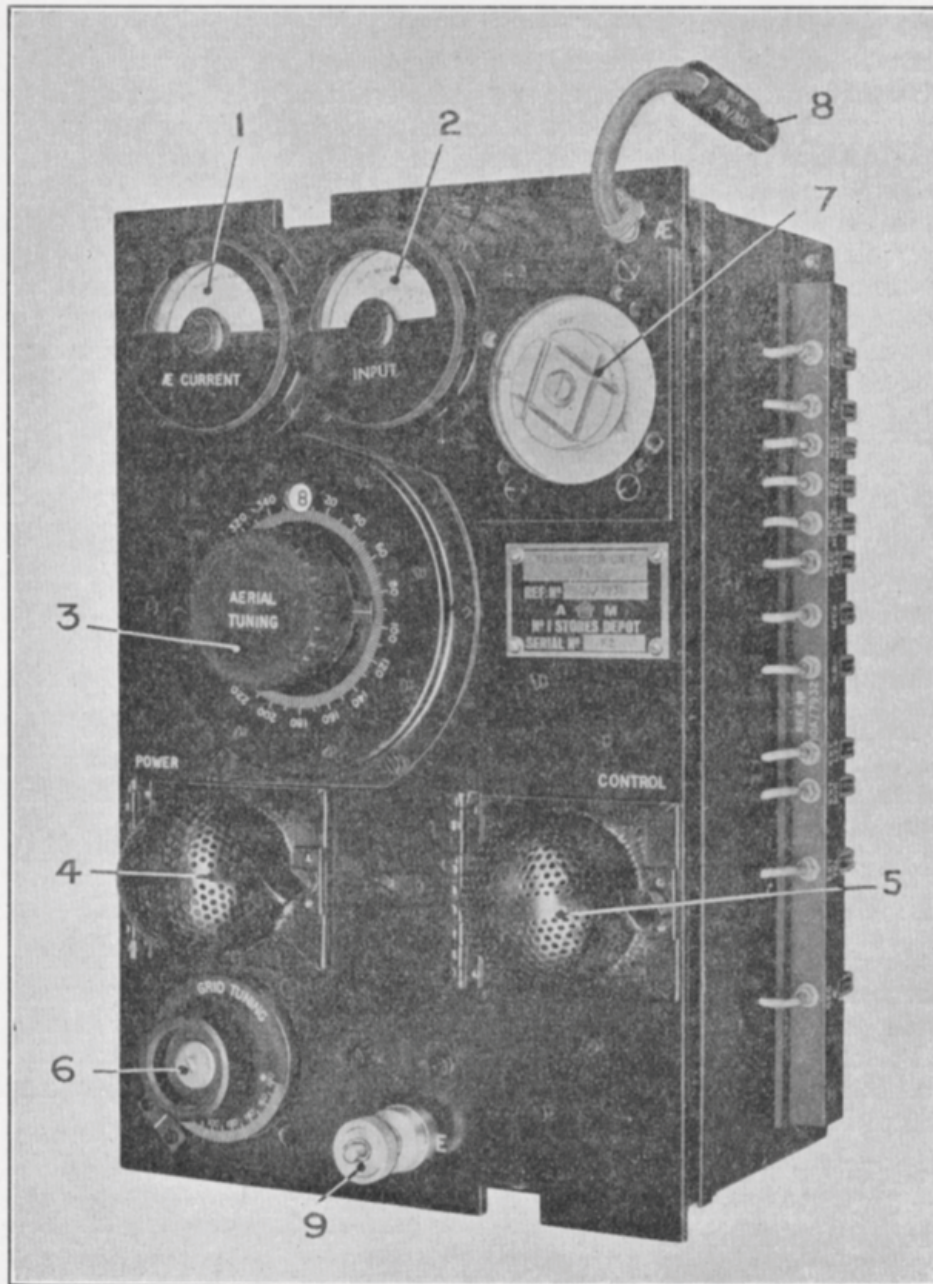


FIG. 2. Transmitter unit removed from case.

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separately tuned by its individual variable condenser to the "spot" frequency. Across each of these main condensers is connected a small fine tuning condenser and the latter three are ganged together. The aerial is loosely coupled to the grid circuit of the valve V_3 through the condenser C_6 , and a static leak R_3 is connected from the aerial side of the condenser to earth. The inductance L_6 , which is of the plug-in type, is connected in the grid circuit of the valve and is tuned by the condenser C_7 . The condenser C_8 is one of the ganged fine tuning condensers referred to previously in this paragraph. The condenser C_9 is not in use on the 6,000 to 4,300 kc/s range but is connected between two pins on the coil-holder so that it may be brought into use in parallel with other plug-in coils. The negative lead of the valve filament includes the biasing resistance R_4 .

12. The screening grid of the valve is fed through the resistance R_5 with which is associated the coupling condenser C_{10} . The resistance is not connected directly to the H.T. + line but terminates on one of the points of a three-point socket, the other two points being connected to H.T. + and earth respectively. Variation of the screening grid voltage is accomplished by connecting, by means of a plug, a remote potentiometer device, incorporating a resistance R_6 . Movement of a contact over the resistance varies the screening grid voltage. The condenser C_{11} shunts the effective portion of the potentiometer and serves to minimize the noise made when adjusting the potentiometer. The anode circuit of the valve V_3 includes the inductance L_6 , which is tuned by means of a main condenser C_{12} and a ganged fine tuning condenser C_{13} in a similar manner to the inductance L_5 . The moving vanes of the two variables are earthed to prevent body capacitance effects and, since the inductance is at H.T. + potential, a blocking condenser C_{14} is inserted in the lead between the condenser and the inductance. A further small fixed condenser C_{15} is connected between the variable condensers and the inductance, for the purpose of opening out the tuning scale. The condenser C_{16} is for a similar purpose to C_9 . It is not in use on the 6,000 to 4,300 kc/s band.

13. The anode of the valve V_3 is coupled to the control grid of the valve V_4 by means of the condenser C_{17} . A variable condenser C_{24} is connected between the anode of the valve V_3 and the anode of the valve V_4 . This acts as the regeneration control, no other regeneration device being employed.

14. The screening grid of the valve V_4 is fed through the resistance R_9 with which is associated the decoupling condenser C_{18} . The potential of the screening grid is controlled simultaneously with that of V_3 . A biasing resistance R_8 similar to R_4 is inserted in the negative filament lead, and a grid leak R_7 is connected between the grid of the valve and earth.

15. In the anode circuit of the valve V_4 is the third plug-in inductance tuned by the condensers C_{19} and C_{20} . The moving vanes are again earthed and a blocking condenser C_{21} is provided to isolate them from the H.T. Scale-opening and packing condensers C_{22} and C_{23} , similar to those on L_6 , are provided.

16. The anode of the valve V_4 is coupled to the grid of the detector valve V_5 by means of the coupling condenser C_{25} , and a grid leak R_{10} is connected from the grid to L.T. — for rectification.

17. The anode circuit of the detector valve includes the dropper resistance R_{11} . Two decoupling condensers are associated with this resistance, one C_{26} being connected from the anode end to earth, and the other C_{27} being connected from the H.T. end to earth. The detector anode is coupled to the grid of the first A/F valve by means of the condenser C_{28} , and included in the grid circuit is a stopper resistance R_{12} . The grid of the valve V_6 is taken to a grid bias lead *via* a resistance R_{13} .

18. The anode of the valve V_6 is fed through a resistance R_{14} , which is decoupled by means of the condenser C_{29} . The anode of this valve is coupled to the succeeding grid circuit *via* the coupling condenser C_{30} and the grid of the valve V_7 is connected *via* the resistance R_{15} to the same grid bias tapping as the grid of V_6 . A second connection extends from the grid of valve V_7 through a resistance R_2 and condenser C_{32} to a terminal marked I.C. This connection is

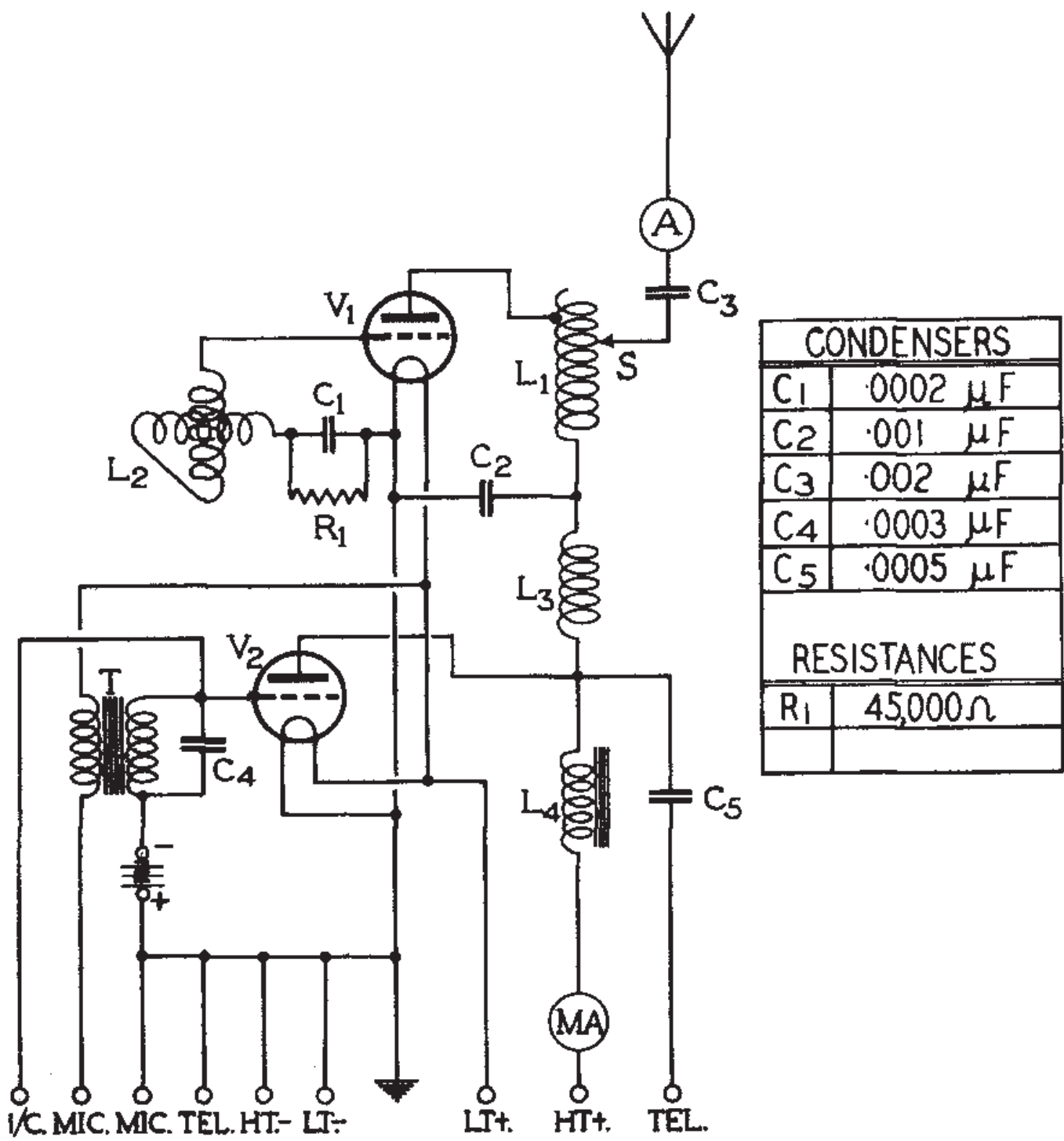


FIG.3, THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER UNIT, TYPE. D.

provided to enable the valves V_7 and V_8 to be used (in addition to their ordinary function) as amplifiers for inter-communication purposes, speech currents from the microphone being impressed on the grid of the valve V_7 via the microphone transformer and the connection referred to above. The amplified speech is reproduced in the head telephones.

19. The coupling between the valves V_7 and V_8 is again by means of resistance-capacitance. The resistance R_{16} in the anode circuit of V_7 has a value of 200,000 ohms and the anode is coupled to the succeeding grid by means of the condenser C_{31} . The grid of the last valve is separately biased, a connection being taken through the resistance R_{17} to a tapping on the grid bias battery. The anode circuit of the last valve includes the low frequency choke L_8 , and the telephones are connected from the anode through the condenser C_{33} to earth. A condenser C_{34} is connected from H.T. + to earth.

CONSTRUCTIONAL DETAILS

Transmitter unit, type D

20. Two views of the transmitter unit are given in figs. 2 and 4 and a bench wiring diagram in fig. 9. All the components of the unit are mounted on the underside of a metal panel which is fitted into a metal screening box. A sub-panel at right angles to the main panel and forming one side of the screening box, carries a row of spring jaw contacts, all connections, with the exception of the aerial and earth, being made through these contacts.

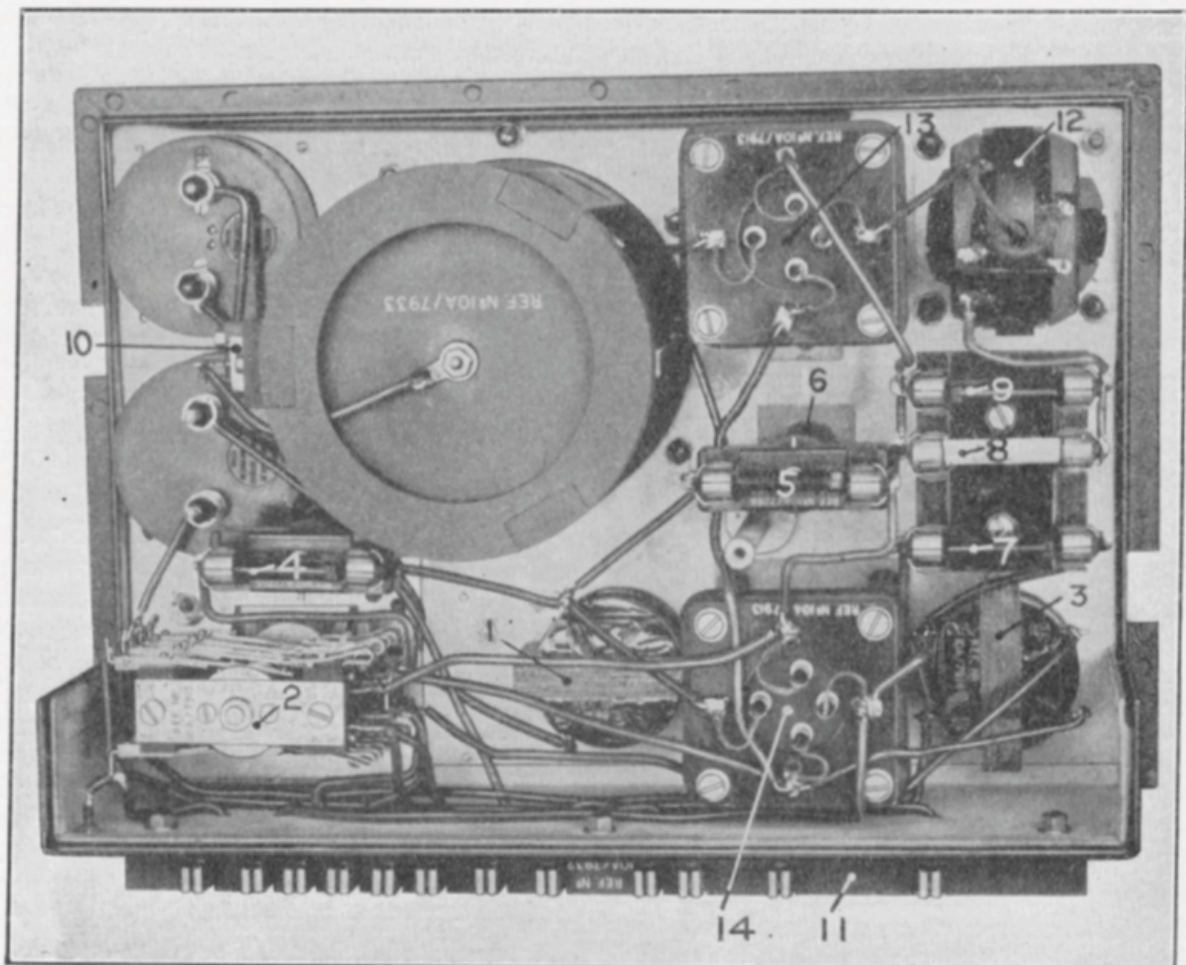


FIG. 4. Transmitter unit, underside view.

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21. Referring to fig. 2, which shows the upper face of the panel, the aerial thermo-ammeter (1) reading 0 to 0.5 amp., can be seen in the upper left-hand corner, the thermo-couple for the instrument being located inside the ammeter case. Adjacent to this is the H.T. milliammeter (2), which reads 0-30 milliamps. Both instruments are fitted with cover plates, that on the thermo-ammeter being engraved *Æ* CURRENT and that on the milliammeter INPUT. Immediately beneath the instruments is the aerial coil. This is a helical coil consisting of 17 turns of silver plated copper tube carried in a frame of composite insulating material fixed to the underside of the panel (*see* fig. 4). Projecting through the panel is a handle (3) which operates a variable tapping on the inductance. The variable contact consists of two spring blades mounted on a nut working on a long brass screw fixed in the centre of the coil. The pitch of the screw is similar to the pitch of the coil, and the screw is surrounded by a sleeve of insulating material slotted along its length to allow the contact to move axially. The sleeve turns with the handle and the spring contact thus travels around the turns of the coil. On the face of the panel a dial engraved in degrees is provided and the knob is provided with a pointer. At the zero position of the dial is a small window at which is displayed a number corresponding to the number of complete turns of inductance in circuit. Intermediate settings are read off against the pointer on the 360 degree scale. For example, a setting of $7\frac{1}{2}$ turns would be indicated by a figure 7 at the window and a 180 degree setting of the pointer. The knob is engraved with the words AERIAL TUNING.

22. The valve-holders are carried on pillars on the underside of the panel and are reached through circular apertures cut in the panel. Over these apertures are fitted hinged perforated screening covers (4) and (5) held shut by screw-fasteners. The panel is engraved at the valve position with the words POWER and CONTROL respectively. Immediately beneath the power valve can be seen the handle (6) of the grid variometer. The handle is engraved with a 180 degree scale and the words GRID TUNING. The grid variometer, which is operated by this handle, can be clearly seen at (12, fig. 4). Both stator and rotor are of ebonite, the stator being wound with 20 turns of 26 s.w.g. D.C.C. wire and the rotor with 21 turns of similar wire.

23. Near the top of the panel on the right can be seen the dog coupling (7) of the send-receive switch. This switch is designed for remote control through a detachable coupling. The coupling is shown in position in fig. 1. The switch itself can be seen in the underside view of the panel (2, fig. 4), and the details of the switch are shown in fig. 16. The switch comprises a drum of insulating material housed in a frame, the drum carrying two rows of projecting studs, the two rows being separated around the drum by 90 degrees of arc. The frame carries two rows of spring contacts, one row on each side, and by rotating the drum through 90 degrees one or other set of spring contacts is closed by the projecting studs. In the intermediate or off position all contacts are open.

24. Referring to the simplified diagram of connections in the lower part of the illustration (fig. 16), it will be seen that there are six pairs of contacts on the "receive" side and five pairs on the "send" side. In the send position the aerial is connected (at contact F) to the transmitter through the aerial ammeter. The anode circuits of the transmitting valves are connected (at contact E) to H.T.+. The telephones are connected (at contact D) through the side-tone condenser to the anode of the modulator valve. The transmitter L.T.+ connection is made (at contact C) to the L.T.+ supply, and (at contact A) the transmitter L.T.— filament connection is joined to the L.T.— supply, H.T.— supply, G.B.+, one side of the telephones, one side of the microphone and earth. In the "receive" position the aerial is transferred (at contact F) to the receiver. The H.T.+ and milliammeter connections are transferred to the receiver (contact E). The telephones are transferred (contact D) to the receiver. At contact C the L.T.+ connection to the transmitter is re-established (this is for the purpose of completing the microphone transformer circuit). At contact B the L.T.+ supply is connected to the receiver, and at contact A the filament circuit of the transmitter is broken and the L.T.—, H.T.— and G.B.+ are transferred to the receiver.

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25. The only other items to be seen on the front panel are the aerial connection (8, fig. 2), which consists of a flexible lead terminating in a plug connection, and the earth terminal (9) bolted to the metal panel of the instrument.

26. The modulating choke (1) which may be seen adjacent to the switch (2) in fig. 4, comprises a core of "radio metal" stampings with a winding of 4,500 turns of 38 s.w.g. enamel and S.S.C. copper wire. The microphone transformer (3) (near the modulator valve-holder) comprises a core of "radio metal" stampings with a primary winding of 200 turns of 34 s.w.g. enamel and S.S.C. copper wire, and a secondary winding of 8,000 turns of 42 s.w.g. enamel and S.S.C. copper wire.

27. Situated under the panel are three platforms, two of which carry a pair of clips while the third carries three pairs of clips. The clip (4) situated near the switch carries a condenser, type 113 ($0.0005 \mu F$), which is connected in series with the telephones across the anode circuit for side-tone purposes. The clip (5) situated on the end of the R/F. choke (6) carries a condenser, type 71 ($0.001 \mu F$), which is connected between the end of the aerial inductance and L.T.—, and acts as a mains oscillating condenser. The third platform carries in the lower clip (7) the grid condenser, type 69 ($0.0002 \mu F$), and in the adjacent clip (8) is carried the grid leak (45,000 ohms). In the upper clip (9) is carried a type 70 condenser ($0.0003 \mu F$) shunting the secondary winding of the microphone transformer. The aerial blocking condenser (15) is a type 24 ($0.002 \mu F$) and is secured to the side of the aerial inductance former. The R/F. choke (6) which can be seen under the mains oscillating condenser consists of a cylindrical former of composite insulating material wound closely with 38 s.w.g. D.S.C. copper wire and has an inductance of approximately 325 mics.

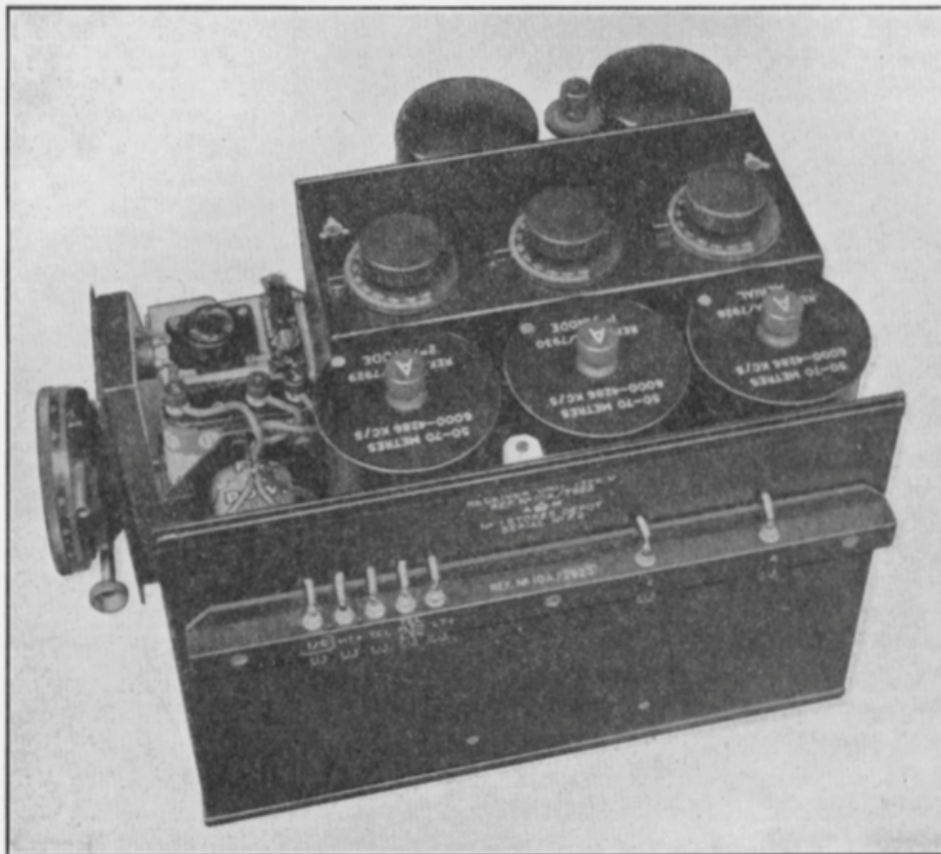


FIG. 5. Receiver unit with coils in position, cover removed.

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28. The contact bar (11) on the side of the transmitter is fitted with 12 spring jaw contacts which, when the instrument is fitted into its case, mesh with the 12 knife contacts on a contact bar (*see* para. 36). In the top right-hand corner may be seen the grid variometer (12), and to the left of it the oscillator valve-holder (13). The modulator valve-holder (14) is to the left of the microphone transformer (3).

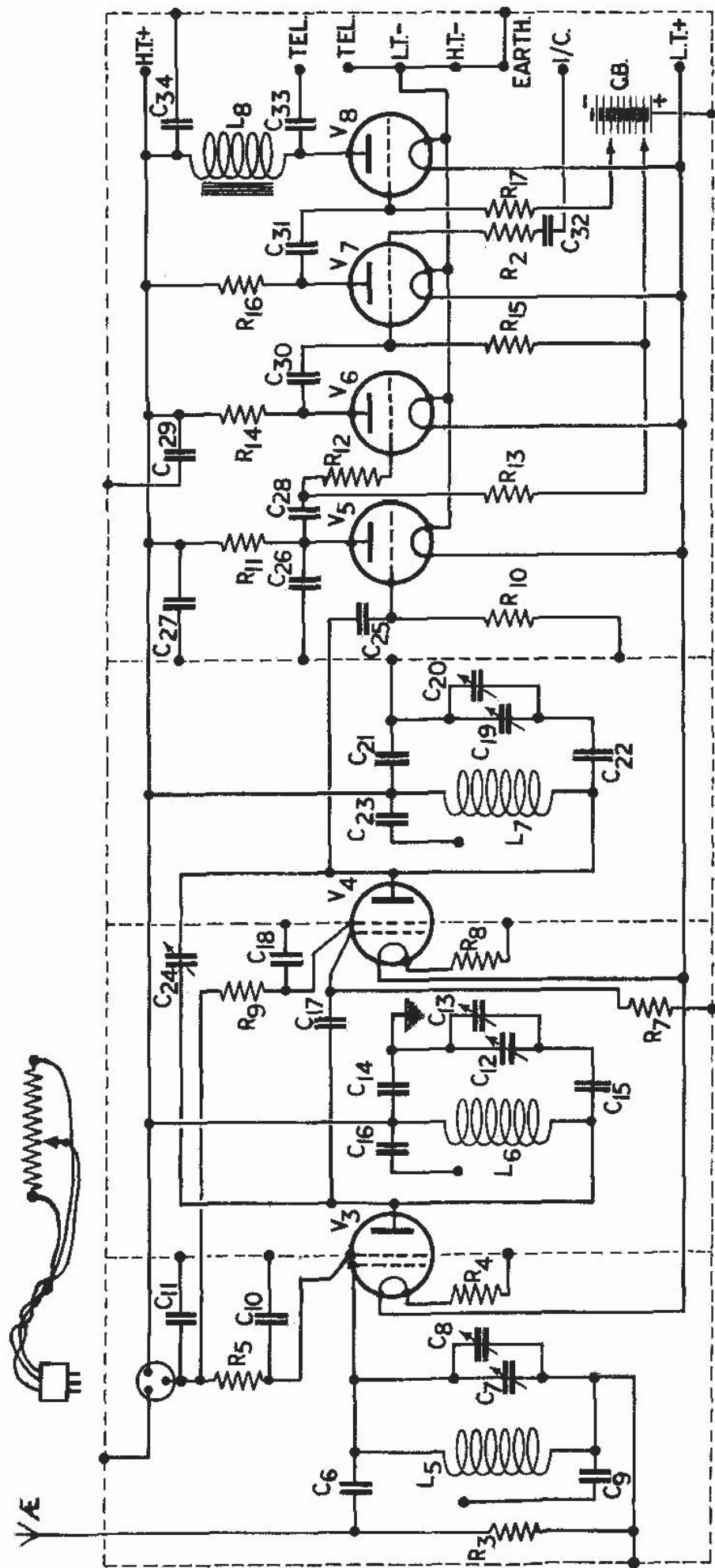
Receiver unit, type D

29. Three views of the receiver are given in figs. 5, 7 and 8, and in fig. 1 it is shown with its screening cover in position and fitted into the transmitter-receiver. A bench wiring diagram is given in fig. 10. The receiver unit case and screening cover are of metal and the components are fitted above and below a main horizontal panel. The space below the panel which is approximately 2 in. deep is divided into four compartments (*see* fig. 8), and screening boxes are fitted on the top of the panel over the condensers, inductances and screen-grid valves (*see* fig. 5).

30. At right angles to the main panel is the sub-panel, also of metal, carrying seven spring jaw contacts through which all connections are made when the unit is in place in its case. Referring to fig. 7 (cover, valves, and coils removed from the instrument), it will be seen that the condenser box (1) occupies the centre portion of the panel, and the valve-holders and coil-holders are grouped around it. The condenser box houses six variable condensers. Three of these ($0.00025 \mu\text{F.}$ each) are mounted with their axes vertical and are independently controlled by three slow-motion handles (2), (3), (4). The other three ($0.00005 \mu\text{F.}$ each), which are in parallel with the above, have their axes horizontal and are simultaneously rotated by means of a common spindle (5) and handle (6). This handle is arranged for remote control. The condenser box is divided up into compartments so that the three pairs of condensers are screened from one another, and all the moving vanes of the variable condensers are earthed to the frame. Two $0.01 \mu\text{F.}$ fixed condensers are located inside this box, and are connected as blocking condensers in the lead between the fixed vanes of the anode tuning condensers and the anode inductances. The pair of aerial tuning condensers is connected directly across the aerial inductance without any series condenser.

31. Immediately in front of the condenser box are the three coil-holders. These are of the five-pin type, the pins engaging with sockets on the base of the coils. The coils can be seen in position in fig. 5. On the other side of the box can be seen the two screen-grid valve-holders complete with their screening cases. A felt ring is provided in each of these cases to prevent accidental contact between the metal coating of the valves and the earthed casing. It is important that there should be no contact here as, owing to the inclusion of the 1.5 ohm biasing resistances in the filament circuit, the metal coating is not at earth potential.

32. Mounted on the condenser box, in a position between the two screen-grid valves, is the regeneration control (7). This consists of a small condenser of the "pre-set" type having a maximum capacitance of $10 \mu\text{F.}$, and it is connected between the anodes of the two screen-grid valves. As will be seen from fig. 5, the handle of this condenser projects through a small aperture in the screening cover of the receiver. The other valve-holders which are of the standard type are arranged in the following order:—detector (adjacent to the screen-grid valve), first A/F. valve, second A/F. valve and output valve. Between the detector and first A/F. valve is mounted a holder (8) carrying a $0.001 \mu\text{F.}$ condenser. This is connected between the anode of the detector valve and earth. Between the first and second A/F. valve is mounted a holder (9) carrying a 2 megohm resistance which is connected as a "stopper" resistance in series with the grid of the first A/F. amplifying valve. The holder (10) situated near the output valve-holder carries a 0.5 megohm resistance. This resistance is in series with the condenser (11), the two being inserted in the inter-communication lead between the grid of the second A/F. valve and the secondary of the microphone transformer. The $4\frac{1}{2}$ -volt grid bias battery (12) is also situated here, one of the negative tapping leads from which is taken to the grid of the first and second A/F. valves, the other being taken to the output valve. The three-point socket (13) serves for connecting up



CONDENSERS μF					RESISTANCES. OHMS				
C1		C0	.5	C8	.00025 variable	C28	.001	R1	In transmitter unit
C2		C1	.5	C20	.00005 variable	C29	.5	R2	.5 M Ω
C3	In	C2	.00025 variable	C21	.5	C30	.001	R3	.5 M Ω
C4	unit	C3	.00005 variable	C22	.01	C31	.001	R4	1.5
C5		C4	.5	C23	50 μF	C32	.0001	R5	20000
C6	50 μF	C5	.01	C24	10 μF variable	C33	.5	R6	50000 variable
C7	.00025 variable	C6	50 μF	C25	.0001	C34	2.0	R7	1 M Ω
C8	.00005 variable	C7	.0003	C26	.001			R8	200,000
C9	50 μF	C8	.5	C27	.5			R9	1 M Ω
								R10	.25 M Ω
								R11	100,000
								R12	2 M Ω
								R13	1 M Ω
								R14	20,000
								R15	1 M Ω
								R16	200,000
								R17	1 M Ω

FIG 6. THEORETICAL CIRCUIT DIAGRAM OF RECEIVER UNIT, TYPE D.

by means of a three-pin plug, the remote volume control. Two of the points of the socket are connected to earth and H.T.+ respectively. The third is connected to the screening grids of the R/F. valves.

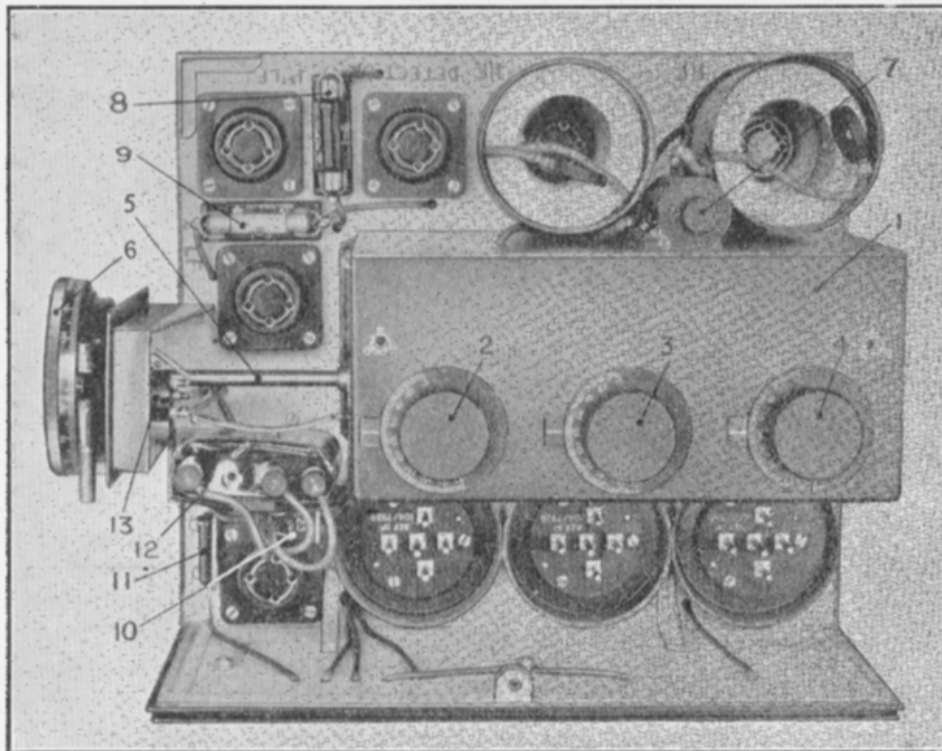


FIG. 7. Receiver unit (cover, coils and valves removed).

33. Referring to fig. 8, which shows the underside of the panel; in the left-hand compartment can be seen the base (1) of the first screen-grid valve-holder, and adjacent to it the 1.5 ohm grid bias resistance (2) which is in series with the L.T.— filament lead. The tin-cased condenser (3), which has a value of $\cdot 5 \mu\text{F.}$, is connected between the screening grid of the valve and earth. The panel (4) carries four clips. In the first clip (5) is a $\cdot 00005 \mu\text{F.}$ condenser connected between earth and the centre pin of the aerial coil-holder, which is intended to function as a packing condenser when such is required across the aerial inductance. The "A" coils have no connection on the centre pin and on this range the condenser is inoperative. The next clip (6) carries a similar condenser which is connected between the grid end of the aerial inductance and aerial. This condenser is the only coupling between the aerial inductance and the aerial. In the next clip (7) is carried a $\cdot 5$ megohm resistance which is connected from the aerial side of the above-mentioned condenser to earth to act as a static leak. A 20,000 ohm resistance is carried in the next clip (8), and is connected in series with the screening grid of the first valve. At the end of the compartment is the base (9) of the aerial coil-holder.

34. In the adjoining compartment is the base of the second screen-grid valve-holder (10), a similar 1.5 ohm biasing resistance (11) and a $\cdot 5 \mu\text{F.}$ tin-cased condenser (12) connected from screening grid to earth. The tin-cased condenser (13), which also has a value of $\cdot 5 \mu\text{F.}$, virtually completes the oscillatory circuit between the earthed moving vanes of the anode tuning condenser and the high potential end of the anode inductance. Of the four clips on the centre panel the first (14) carries a $\cdot 00005 \mu\text{F.}$ condenser. This is connected to the coil-holder pins in a similar manner to the condenser (5) on the aerial inductance. It is likewise inoperative with the "A" coils. The next clip (15) carries the coupling condenser ($\cdot 0003 \mu\text{F.}$) connected between the anode of the first R/F valve and the grid of the second. The clip (16) carries a 1 megohm resistance which is connected between the control grid of the second R/F. valve and earth. The 20,000 ohm resistance in the next clip (17) is in series with the screening grid of the second valve.

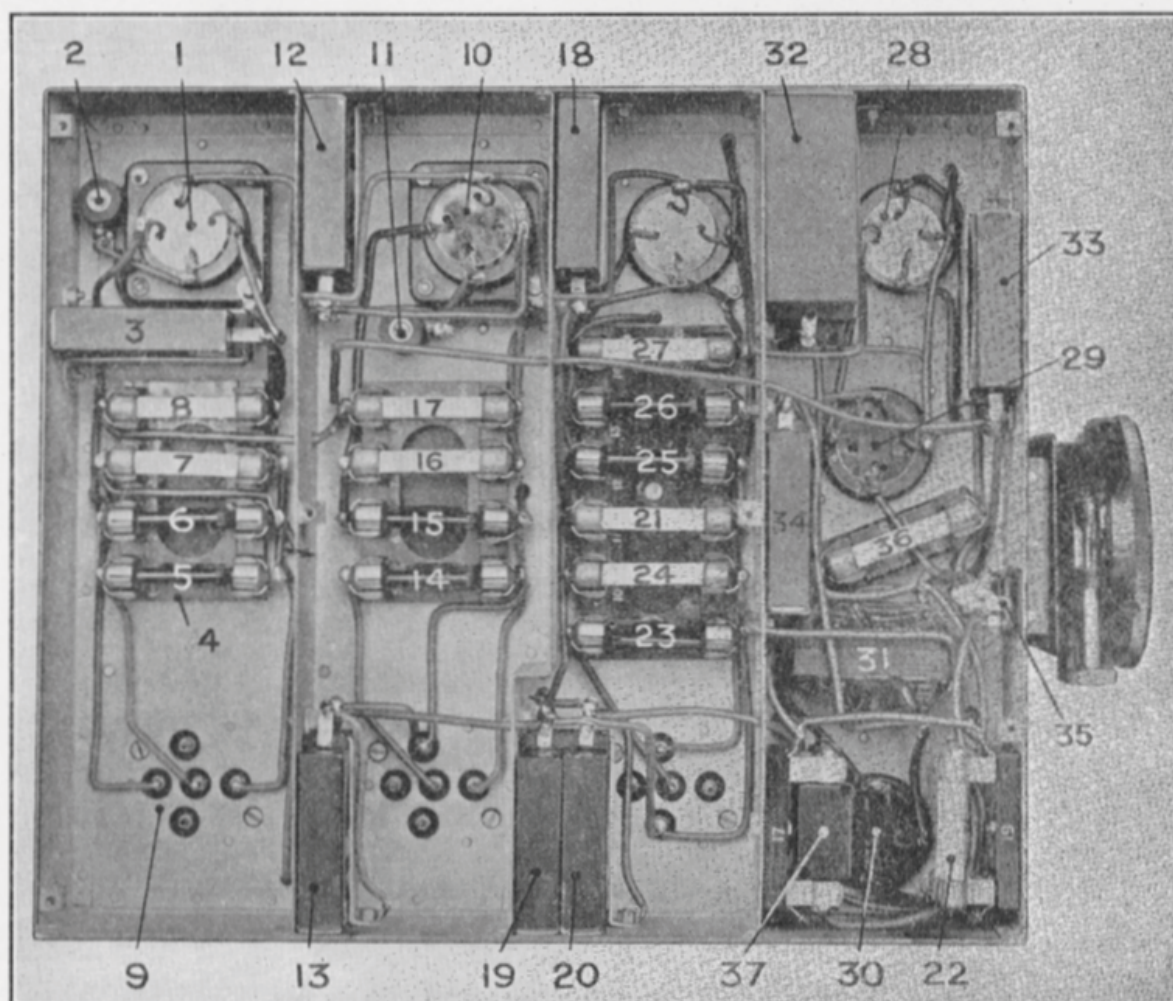


FIG. 8. Receiver unit, underside view.

35. The next compartment contains three tin-cased condensers, each of which has a capacitance of $\cdot 5 \mu\text{F}$. The condenser (18) near the valve-holder is a series blocking condenser which carries out a similar function to the condenser (13) previously mentioned. The condensers (19) and (20) are joined together at one side and the common connection earthed. The other sides are connected to the high potential ends of the resistances (21) and (22) to act as decouplers. The first clip (23) on the centre panel carries a $\cdot 00005 \mu\text{F}$ condenser which is connected to the centre pin of the coil-holder in the same manner as the "packing" condensers (5) and (14) previously described. It is inoperative with the "A" coils. The next clip (24) carries a 1 megohm resistance connected in the grid bias lead of the first A/F. valve. The 100,000 ohm resistance (21) is in the anode circuit of the detector valve and the $\cdot 001 \mu\text{F}$ condenser in the next clip (25) couples the anode of the detector valve to the succeeding grid. The $\cdot 0001 \mu\text{F}$ condenser in the adjacent clip (26) is the detector grid condenser and the $\cdot 25$ megohm resistance (27) the grid leak.

36. In the right-hand compartment can be seen the bases of the three valve-holders (28), (29), (30) for the A/F. valves and also the output choke (31). Three tin-cased condensers are fitted in this compartment. The condenser (32) in the corner has a capacitance of $2 \mu\text{F}$, and is connected as a decoupling condenser from the high potential side of the output choke to earth. Of the other two condensers (33) and (34), each of which has a capacitance of $\cdot 5 \mu\text{F}$, one is connected from the anode of the output valve to one side of the telephones, the other is connected between the mid-point of the three-way volume control socket and earth. The small condenser (35)

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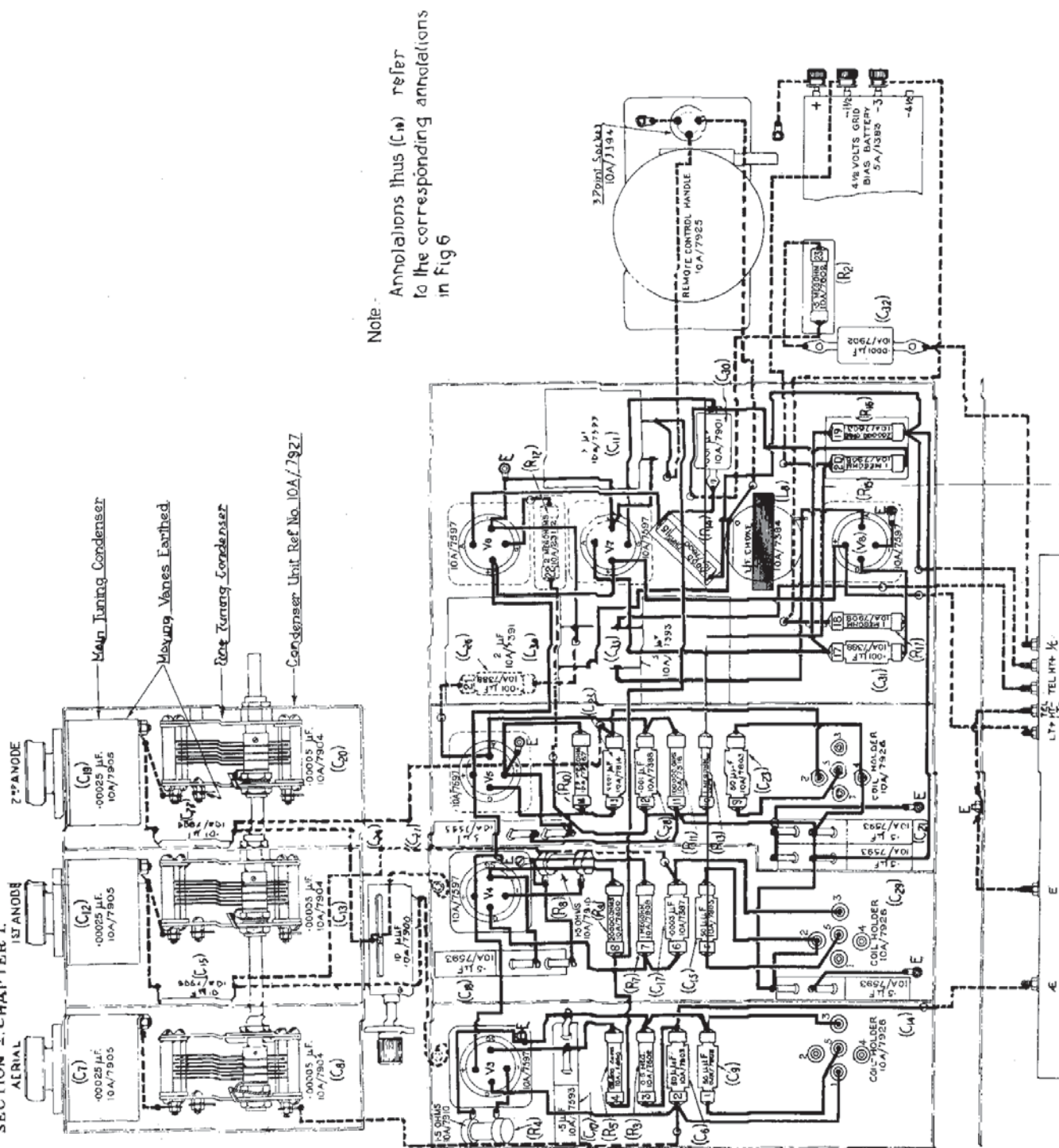


FIG. 10 BENCH WIRING DIAGRAM OF RECEIVER UNIT TYPE D.

which has a value of $\cdot 001 \mu\text{F.}$, is the coupling condenser between the anode of the first A/F. valve and the grid of the second. The resistance in the holder (36) has a value of 20,000 ohms and is connected in the anode circuit of the first A/F. valve. In the corner of the compartment are two small panels. The one on the left carries a $\cdot 001 \mu\text{F.}$ condenser (37) and a 1 megohm resistance, the former being the coupling condenser between the anode of the second A/F. valve and the grid of the output valve, and the latter the grid resistance in the grid bias lead to the output valve. The panel on the right carries the 200,000 ohm anode resistance (22) of the second A/F. valve and also the 1 megohm resistance in the grid bias lead of the second A/F. valve.

Coils

37. The receiver coils, of which there are three, are shown in position in fig. 5. The three coils form: the aerial inductance, first anode inductance and second anode inductance. They are engraved on their top plates with the words AERIAL, 1ST ANODE and 2ND ANODE respectively and, in addition, with the Stores Ref. No. and the range in metres and kilocycles. As a precaution against incorrect insertion each of the coils has a coloured dimple which corresponds with a similarly coloured dimple on the cover of the receiver. The colour for the aerial coil is red; for the 1st anode, green and for the 2nd anode, yellow. Each coil unit consists of a zinc sprayed aluminium container approximately $2\frac{1}{2}$ in. diameter and $5\frac{1}{2}$ in. long, closed at the top with a circular duralumin cover plate to the centre of which is fitted an ebonite lifting knob. In the other ends of the container is fitted a circular ebonite plate drilled with five holes into which are pressed brass bushes. On the inside face of the ebonite plate are five special phosphor-bronze spring contacts. Inside the metal container is the coil former carried on four short ebonite pillars mounted on the ebonite end plate. The coil former consists of an ebonite tube with external longitudinal flutes. A thread is cut around the former with a pitch of seven turns to the centimetre, and bare tinned copper wire is wound in the groove so formed. The windings of all three coils are similar, *viz.*, fourteen turns of 20 s.w.g., but the connections of the ends of the coils to their bases are different. Fig. 15 shows the three different arrangements of connection for the three coils.

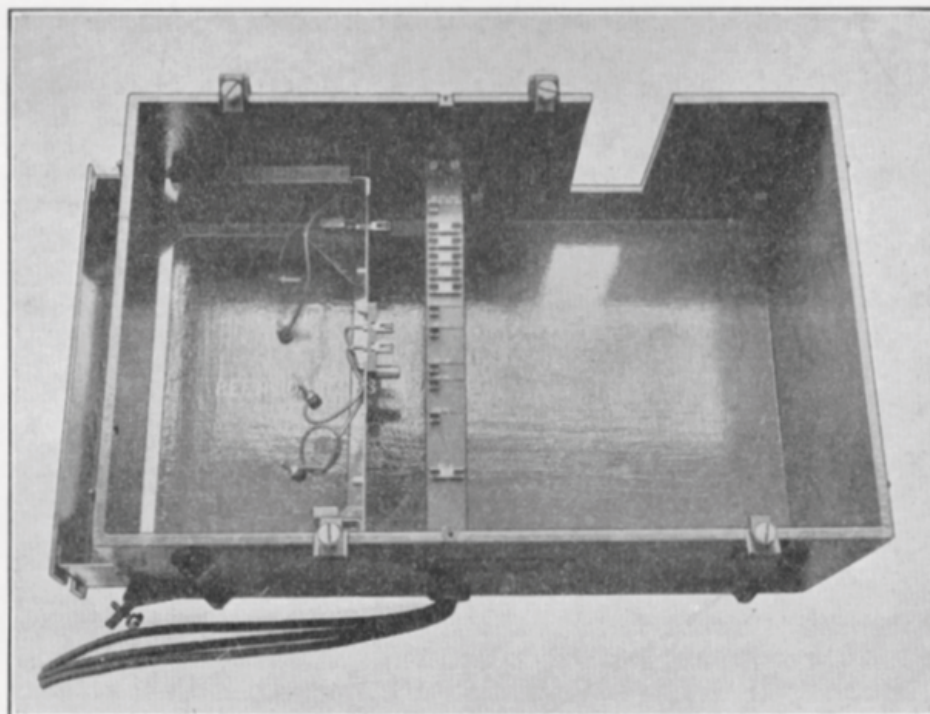


FIG. 11. T.R.9 case, transmitter and receiver units removed.

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Case

38. The transmitter and receiver units are housed together in a special case, and are shown in position in fig. 1. In fig. 11 the case is shown with the units removed. It is constructed of wood covered with fabric and painted grey. A main contact bar (fig. 12) is fitted within and from the underside of the contacts flexible connections are taken out through a bush. When the units are in position, spring jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads terminating in plugs, the batteries are connected up to three spring contact jaws on the tray, and when the tray is in position these three spring jaws engage with three knife contacts on the underside of the main contact bar. The engravings near the various contacts are clearly shown in fig. 12. The transmitter contact bar and receiver contact bar are shown disengaged from the main contact bar, and on the left is the tray withdrawn from engagement. It should be noted that the tray passes under the transmitter contact bar.

Transit case

39. A transit case is provided for carrying the transmitter-receiver. It is constructed from yellow deal painted grey. The dimensions are approximately 1 ft. 9 in. $\times$ 1 ft. 3 $\frac{3}{4}$ in. $\times$ 10 $\frac{1}{4}$ in., and the case accommodates the completely assembled instrument. The hinged lid is securely fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROL

40. In single-seater aeroplanes the wireless apparatus is usually installed behind the pilot's cockpit and, to enable the pilot to operate the instruments, remote control apparatus must be employed. The apparatus used for this purpose with the T.R.9 is illustrated in fig. 17. The remote controller (*see* fig. 13) comprises an aluminium casing carrying three handles, two of which operate through a modified form of bowden cable, the other operating electrically. The design is such that the controller may be separated into two units, the mechanical portion (Stores Ref. 10A/7939) and the electrical portion (Stores Ref. 10A/7937). In fig. 13 they are shown assembled as one unit (Stores Ref. 10A/7936). The mechanical portion consists of two rotatable metal plates with portions cut away for lightness. Each plate is operated by a separate handle and the movement of the plates is transmitted to the SEND-RECEIVE switch and receiver condenser by flexible shafts sliding in solid drawn brass tubes. The flexible shaft clamped to one of the plates terminates at its other end on the receiver condenser head and operates this condenser in the manner described in para. 6. Movement of the controller handle from 0 to 180 on the scale causes the ganged condensers on the receiver to rotate through 180 degrees. The flexible shaft clamped to the other plate terminates at its other end on the send-receive switch. The operating handle may be placed in either of three positions marked SEND, OFF, RECEIVE, and is provided with a bolt for locking it in the "Off" position. The operation of the handle moves the barrel of the switch unit into either of its three positions as explained in para. 23.

41. The electrical portion of the controller which provides for remote volume control of the receiver is carried in a moulded cover (*see* fig. 13). Twenty-one fixed resistances are mounted in an ebonite former which is secured to the inside of the cover. The resistances are connected in series (*see* fig. 14), and connections are taken from the junction points to 20 brass contact studs mounted in a ring of composite insulating material. Over these contact studs travels a phosphor-bronze contact brush which makes contact between the contact studs and a slip-ring. The brush is rotated by a moulded handle which is engraved with a 0 to 20-scale, and

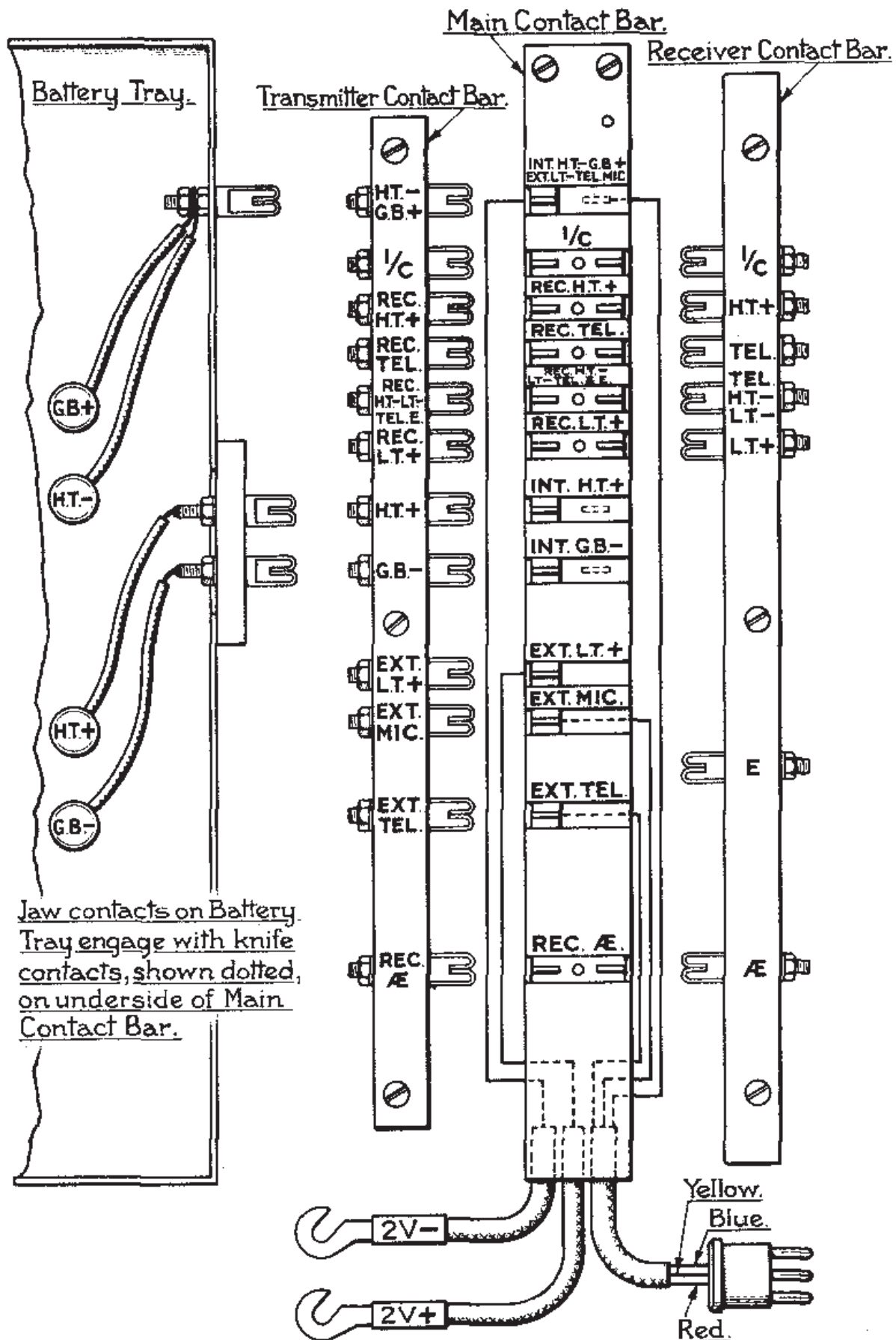


FIG 12 CONTACT CONNECTIONS OF TRANSMITTER, RECEIVER AND BATTERY TRAY WITH MAIN CONTACT BAR

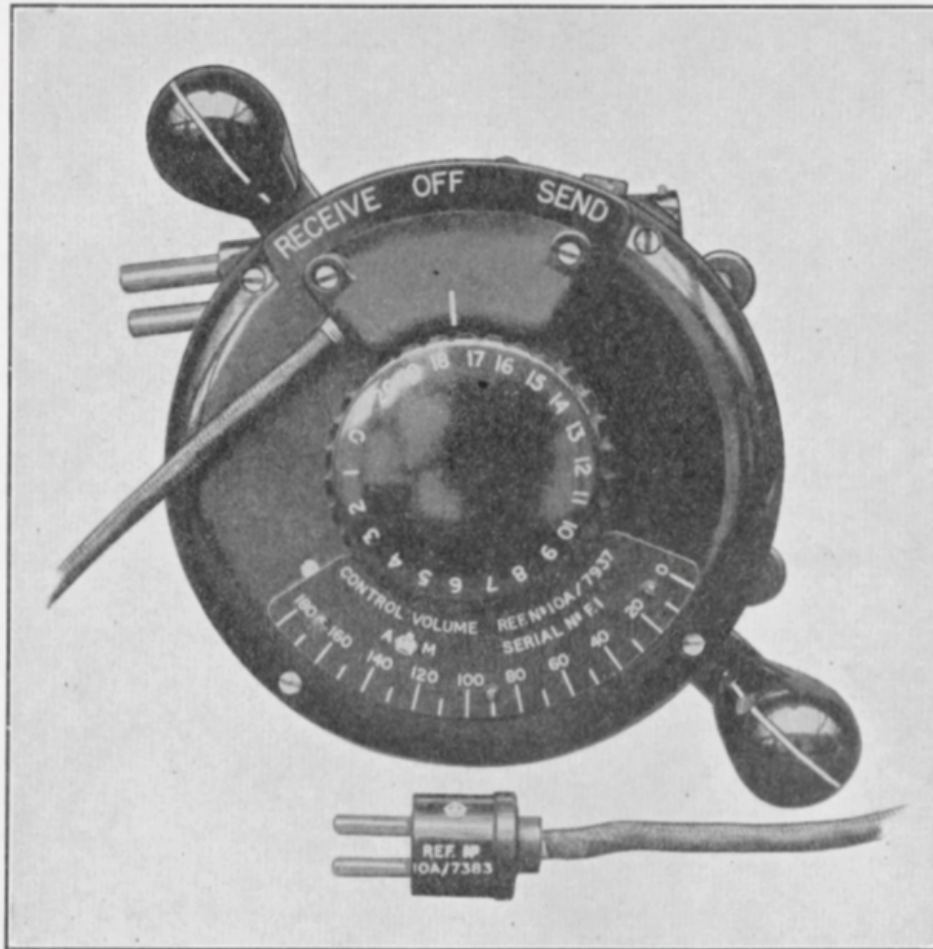


FIG. 13. Remote controller.

a 3-core flexible cable is led into the controller, the three cores being coloured blue, red and yellow. The blue and yellow cores are connected to the ends of the first and last resistances, and the red core to the slip-ring. The other end of the 3-core flexible cable terminates in a 3-pin plug which engages with a socket on the receiver, the yellow lead being thereby connected to H.T.+, the blue lead to H.T.— and the red lead to the screening grids of the two R/F valves. As a result, the total resistance of the controller (57,900 ohms) is connected across the H.T. supply, and the movement of the brush simultaneously varies the potential applied to the two R/F screening grids between approximately 10 and 110 volts.

42. It will be observed that the values of the resistances have been chosen so as to produce a "tapered" control. When the moulded handle is turned in a clockwise direction, the dial reading progressively increases, but the voltage applied to the screening grids increases at first slowly and then rapidly. For the first part of its rotation it passes over resistances of comparatively small value and the voltage drop over these being small (of the order of one volt per 500 ohms), a variation of about 16 volts occurs over the first 10 studs (half the scale). Movement of the handle over the next 5 contacts, however (from 10 to 15), gives an increase of over 20 volts. Over the remainder of the scale an increase of approximately 62 volts results. It will be seen that this arrangement effectively provides for smooth adjustment of the screen grid voltages around the values generally required in operation.

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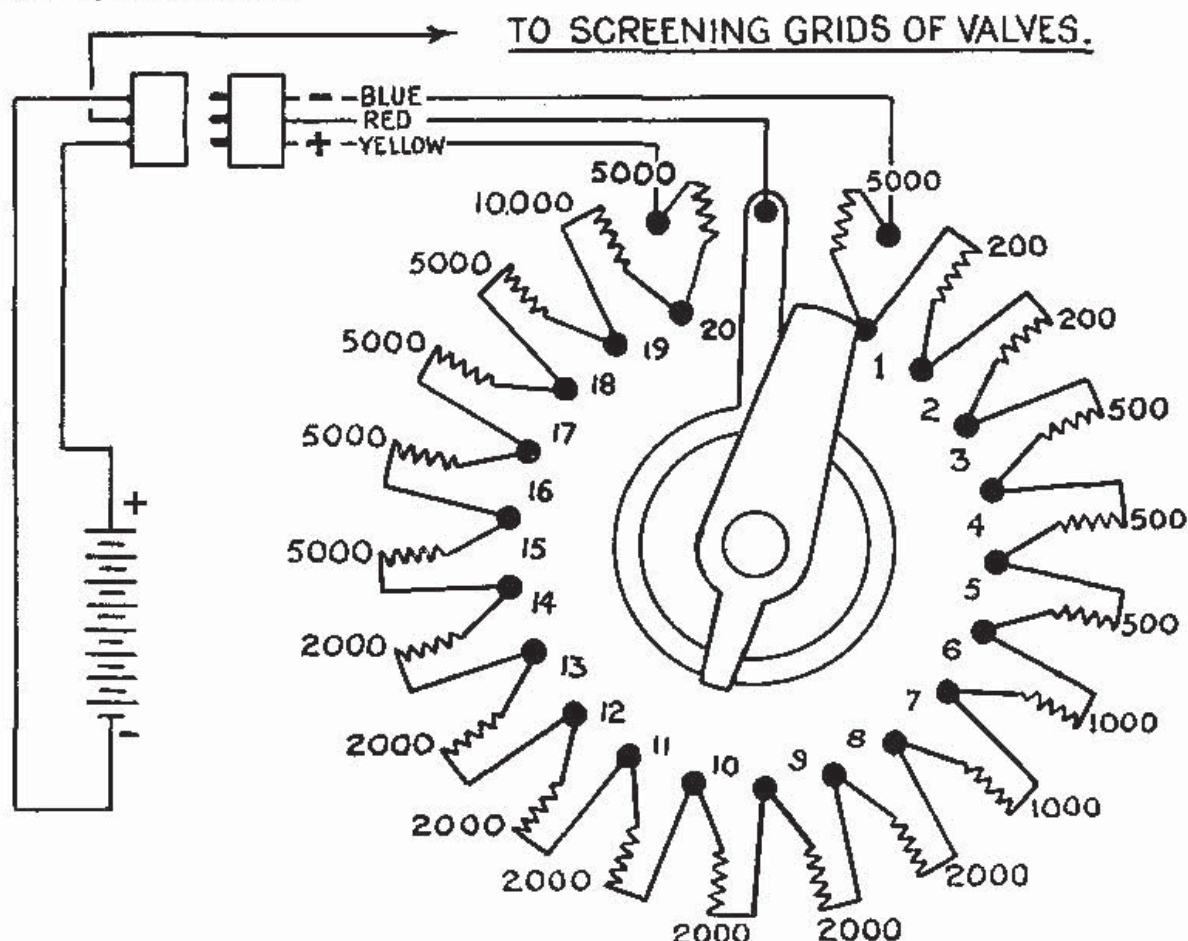


FIG. 14. Diagram of electrical portion of remote controller.

VALVES AND BATTERIES

43. Both oscillator valve and modulator valve in the transmitter are of the same type, *viz.*, V.T.20, having a filament consumption of .2 amp. at 2 volts. The receiver employs two screen-grid valves (V.R.S.G.18) having a filament consumption of .15 amp. at 2 volts, a detector valve and two A/F valves (V.R.21) having a filament consumption of .1 amp. at 2 volts and an output valve (V.R.22) having a filament consumption of .2 amp. at 2 volts.

44. The current for the transmitter and receiver filaments is supplied from a 2-volt accumulator (Stores Ref. 5A/1387). The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery (Stores Ref. 5A/1333) housed in the case of the transmitter-receiver.

45. A maximum load of 15-18 milliamps is imposed upon the H.T. battery when the transmitter is in use. The battery should be tested frequently and, if the reading on load is less than 100 volts, the battery should be replaced. A 15-volt grid bias battery is employed to bias the modulator valve of the transmitter and a $4\frac{1}{2}$ -volt grid bias battery is employed to bias the A/F valves and output valve of the receiver. The 15-volt battery is housed with the H.T. battery in the special tray in the transmitter-receiver case, but the $4\frac{1}{2}$ -volt battery is accommodated in the receiver itself.

INSTALLATION

46. A typical installation diagram for a single-seater fighter is given in fig. 18. The whole of the apparatus is carried on a tray slid into position on runners and situated behind the pilot's cockpit. The tray complete with instruments and batteries may be withdrawn from the

aeroplane by releasing two bolts which engage with the runners. The H.T. and G.B. batteries for the transmitter and receiver are located in the instrument case.

47. The aerial connection is made by means of a flexible lead on the transmitter terminating in a plug connection. The earth connection is made by means of a flexible connection between a terminal on the panel of the instrument and a spring terminal on the aeroplane frame. A three-core cable terminating in a three-pin plug extends from the instrument and engages with a three-point socket on the aeroplane. From this socket leads are taken to the microphone and telephone circuits. In a two-seater aeroplane duplicate telephone and microphone positions are wired to the socket to allow inter-communication, the receiver being utilized for the inter-communication amplifier.

48. When the send-receive switch is in the "receive" position the microphone is still connected through its transformer to the A/F. amplifying parts of the receiver, speech currents are impressed on the grid of the second A/F. valve and speech is heard in the telephones (which are now in the anode circuit of the last valve) in the same way as the incoming R/T. signals.

49. As will be seen from the illustration, the remote control connections extend from the instrument to a convenient position for operation. They comprise two solid-drawn brass tubes with internal flexible shafts and a metal-braided electrical cable. The two flexible shafts operate the tuning condensers and send-receive switch respectively, and terminate at the instrument in detachable fittings, that at the switch taking the form of a coupling incorporating a rack, and that at the condenser being a condenser-head incorporating special mechanism. The metal-braided electrical cable is in the screen grid control circuit and terminates in a three-pin plug which engages with a three-point socket on the instrument. The remote controller carries three handles, one for each of the above-mentioned controls.

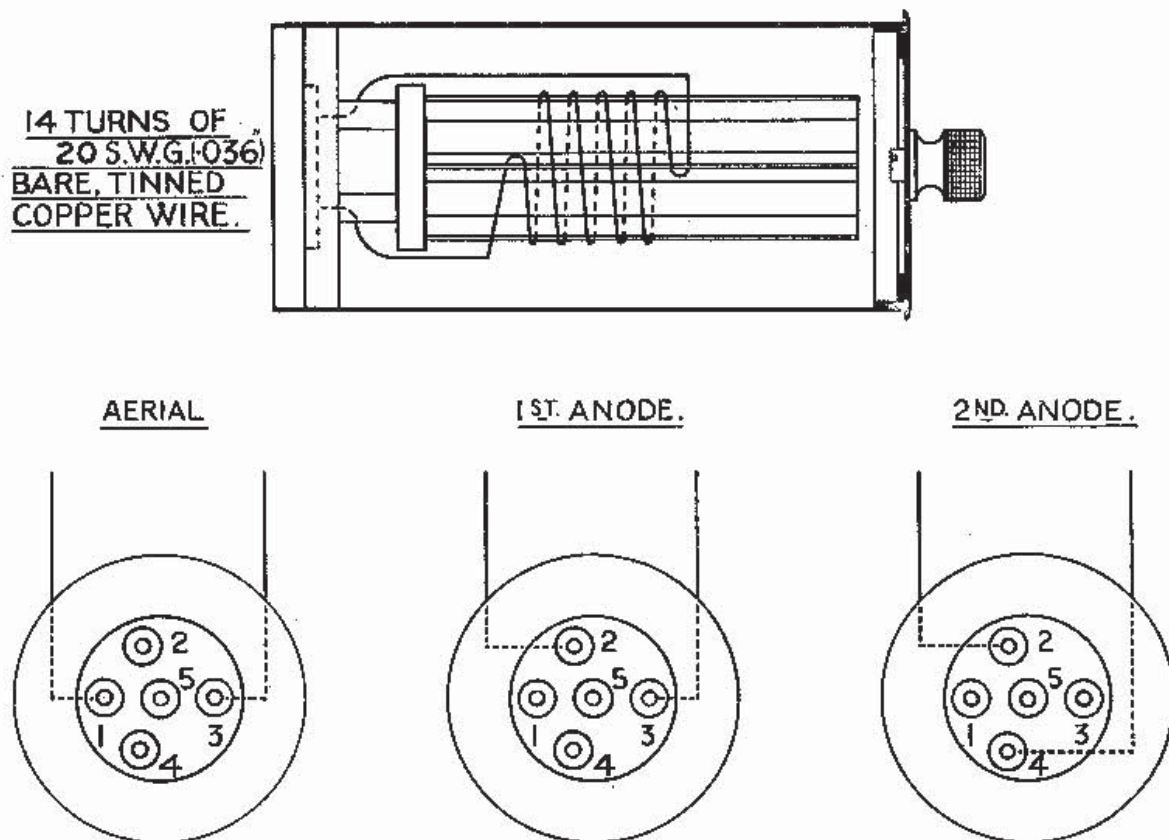


FIG. 15. Receiver coil connections (6,000 to 4,300 kc/s.).

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OPERATION

Adjustment of the transmitter

50. Wavemeter W.69, described elsewhere in this publication, should be used to adjust the frequency. Place the wavemeter about 6 ft. from the aerial and in such a position that the micro-ammeter on the wavemeter is clearly visible from the cockpit of the aeroplane. Adjust the wavemeter to the desired frequency.

51. Before switching on, adjust the aerial coil and grid variometer on the transmitter to approximately the required frequency. It should be noted that with the grid variometer at maximum the aerial coil should also be at its maximum adjustment, but with the grid variometer at zero the corresponding aerial coil adjustment is about six turns.

52. Set the send-receive switch to SEND and observe the readings on the aerial ammeter and the H.T. milliammeter. The aerial current should be about .25 amp. and the input 15 to 17 milliamps.

53. Adjust the grid variometer and aerial inductance until a maximum reading is obtained on the wavemeter micro-ammeter. A movement of one of the tuning adjustments should be immediately followed by a corresponding movement of the other. The grid variometer should be adjusted in such a way as to obtain minimum input (as shown on the H.T. milliammeter) and *not* maximum output as shown on the aerial ammeter. This procedure is essential in order to avoid instability. Table 1 gives representative figures of the tuning adjustments of the transmitter when fitted on a "Hart" aeroplane employing a wing-tip-to-tail aerial.

54. The weakest possible coupling between the transmitter and wavemeter should be used in order to avoid overloading of the wavemeter micro-ammeter, and the transmitter must always be tuned to the wavemeter and not *vice versa*.

Table 1

Frequency kc/s.				Aerial coil turns.				Grid variometer degrees.
4,286	..	..	..	14.0	..	..	..	115
4,700	..	..	..	12.0	..	..	..	90
5,120	..	..	..	10.0	..	..	..	70
5,710	..	..	..	8.0	..	..	..	35
6,010	..	..	..	7.0	..	..	..	30

Adjustment of the receiver

55. The receiver may be tuned by two different methods. The first method is to adjust the transmitter unit of a similar instrument to the required frequency and to tune the receiver directly from this. The second method is to adjust the transmitter of the same, or any similar instrument, to the required frequency, tune an R/T tester or W.39 wavemeter from this and then tune the receiver from the R/T tester or W.39 wavemeter. The two methods are described in full below.

56. To tune the receiver directly from a transmitter, the transmitter unit of another instrument of the same type must first be tuned to the frequency required by the method described above for transmitters. For this purpose it should be set up with a condenser of about 100 micro-microfarads connected between the aerial and earth terminals instead of connecting the aerial. A microphone must be connected up to the transmitter, and with the switch turned to SEND, a constant modulation must be applied. For satisfactory tuning the signal strength received should be adjusted to about strength 5 by moving the transmitter or decreasing its radiation. The receiver is then tuned as follows.

57. Operate the switch of the transmitter-receiver to RECEIVE, turn the volume control to about 15, and set the regeneration control so that the receiver does not oscillate.

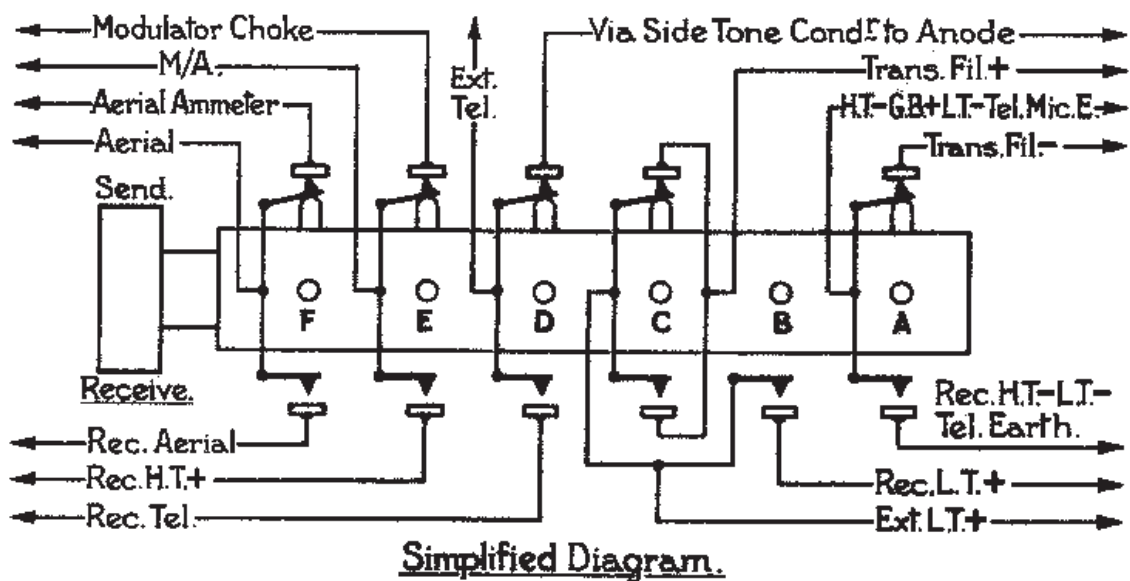
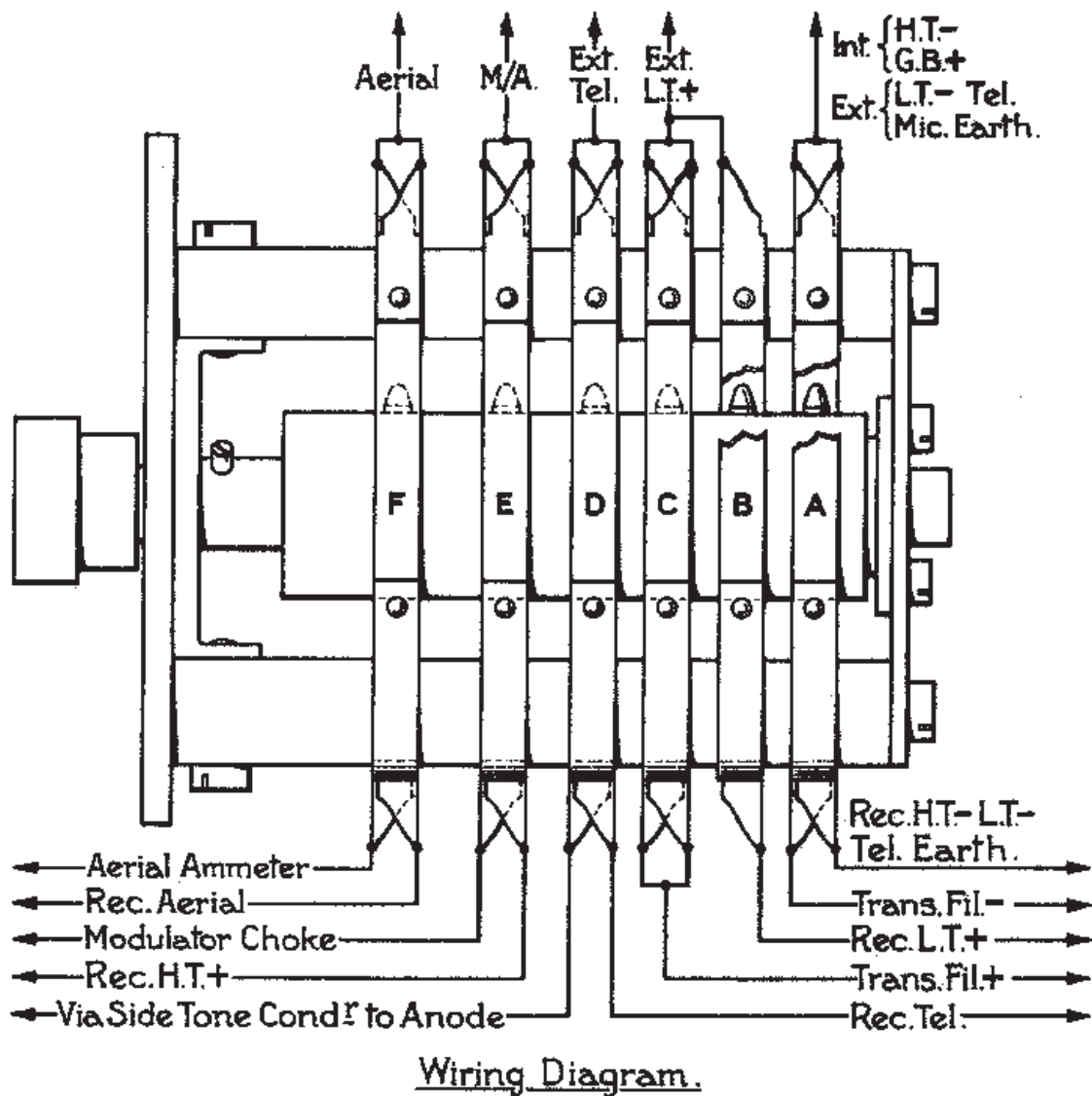


FIG. 16, SEND-RECEIVE SWITCH

58. Set the tuning control to about 105 degrees, that is, to about the middle of its frequency range. Adjust the main tuning condensers (2, 3, and 4, fig. 7) to obtain the maximum signal strength in the telephones connected to the receiver.

59. Turn the regeneration control counter-clockwise until the receiver begins to oscillate, and then turn it back until oscillation just stops. A further adjustment of the main tuning condensers will now be required to obtain maximum strength. The tuning and regeneration should be adjusted alternately until a condition is reached when no further improvement is obtained.

60. Turn the volume control and observe the variation in signal strength. The strength should increase uniformly up to a maximum, which occurs before the control reaches the upper end of its range. Turn the tuning control throughout its range and ensure that the receiver is stable in all positions.

61. Alternatively, the receiver may be tuned by means of the R/T tester, type 1, or the wavemeter W.39. If the tester is used, unit A only will be required. The method is as follows. Set the transmitter unit of the instrument to the frequency required as described above for the adjustment of the transmitter. Place the wavemeter, or the unit A of the tester, close to the transmitter, connect a pair of telephones to it and switch to C.W. Switch the transmitter-receiver to SEND and tune the wavemeter or tester to obtain a zero beat frequency. Without disturbing the setting, switch to T.T. and switch the transmitter-receiver to RECEIVE. Tune the receiver as described in the previous paragraph.

62. These methods have the advantage that all frequencies are set from one wavemeter and their accuracy will therefore depend only on the care taken in the operations. The calibration of the R/T tester should not be used and the calibration of the wavemeter W.39 should be used only if no other standard is available.

PRECAUTIONS AND MAINTENANCE

Transmitter-receiver

63. On the ground the send-receive switch which is embodied in the transmitter-receiver should be locked in the "off" position as a safeguard against the batteries becoming discharged, but immediately before leaving the ground, the handle should be moved to the "receive" position and, except when actually transmitting, it should be maintained in this position so that the apparatus is ready to receive a call. A ground transmission and reception test should be carried out prior to the flight.

64. The low tension battery should be removed for recharging at frequent intervals. The high tension battery, which is a common battery for both transmitter and receiver, should be renewed if the voltage falls below 100 volts when tested on load. Both the H.T. battery and the transmitter grid bias battery are situated in a tray in the interior of the instrument case. To inspect these, it is only necessary to open the door in the end of the case and slide out the tray. Should any difficulty be experienced in withdrawing the tray, see that the plugs which fit into the H.T. and grid bias are not too high. The plugs in question are types 91, 93 and 94, and should the contact pin be greater than the depth of the socket, the plug should be cut down so that when inserted in the socket, the shoulder of the plug will bear against the shoulder of the socket.

65. It is possible to test the voltage of the H.T. battery without withdrawing the tray. For this purpose a simple connecting lead may be made up, which when used in conjunction with test meter, type C (Stores Ref. 10A/8744), enables the voltage of the H.T. battery to be tested in position and on load. A three-pin plug, type 48 (Stores Ref. 10A/7383), is joined by a suitable length of cable (Liflex 4, Stores Ref. 5A/193), being suitable for the purpose, to one plug, type 65 (Stores Ref. 10A/8262), engraved H.T. — and one plug, type 64 (Stores Ref. 10A/8261

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engraved H.T.+ . Insert the plugs in the test meter before the three-pin plug is inserted in the volume control socket of the receiver. Care should be taken to see that the send-receive switch is in such a position that the H.T. battery will be "on load" when the test is made.

66. The input current to the transmitter must be carefully checked periodically. With the modulator valve removed, the input to the oscillator should be of the order 7 to 8 mA. With the oscillator valve removed the modulator input should be of the order of 7 to 8 mA., and any variation from these figures must be corrected by careful adjustment of the transmitter grid bias battery.

67. The grid bias battery for the receiver is situated within the receiver and in order to gain access to this it is necessary to remove the cover from the receiver. Periodical checks should be made to ensure that the voltage is normal, and that the plugs are properly fitted. If this battery is faulty, distorted speech, as well as an unduly heavy drain on the high tension battery, will result.

68. As the H.T. milliammeter is connected to the H.T.+ lead in both "send" and "receive" positions of the switch, care should be taken to ensure that the H.T. battery is not subjected even momentarily to any load beyond the capacity of the milliammeter. For this reason the H.T. should be open-circuited when carrying out such operations as inserting screen-grid valves owing to the possibility of the anode lead touching some portion of the earthed case.

69. In single-seater aeroplanes, where during reception the mask microphone is left switched on and where inter-communication is not required, an improvement in the signal-to-noise ratio may be effected by removing the resistance from the clip numbered 23 in the receiver unit, shown at (10) in fig. 7, close to the output valve. The resistance corresponds to R_{18} in fig. 6 and its removal disconnects the inter-communication circuit which otherwise permits the amplified noise from the microphone to reach the telephones. The resistance must be replaced in the clip when the transmitter-receiver is returned to store.

70. The following modification is to be made on all instruments not already modified to prevent the flexible rubber-covered lead connected to the moving part of the regeneration condenser from fouling the moving vanes of the ganged condenser. Remove the receiver unit from the case and take off its cover. Remove the top covers of the two valve cans. Pull out any slack wire left inside the condenser compartment and secure with a light whipping round the wire, close up to the aperture. Arrange the two sets of leads to the regeneration condenser as far apart as possible. Turn the regeneration control knob clockwise till the leads are at the top of their travel and pull any slack wire towards the detector valve. Replace the valve covers and receiver cover and replace the receiver in the case. Reset the regeneration control.

71. When the receiver is being operated on the bench a separate handle, remote control, condenser unit (Stores Ref. 10A/7925) should be used to turn the ganged condensers. This is fitted on to the condenser in the same way as the handle attached to the remote controls.

Remote control

72. It is essential that the remote control mechanism be so adjusted that the controls on the instrument always occupy their correct positions when moved by, and as indicated on, the remote controller. Once set, the adjustment need never be interfered with, the method of coupling to the transmitter-receiver being such that the controls can be disconnected from the instrument, when it is necessary to remove the latter from the aeroplane, without in any way affecting the synchronism. The controls may be disconnected from the instrument in the following way.

73. Referring to fig. 17, slacken the knurled screw (1) and lift the condenser head (2) clear from the condenser. Slacken the screws (3) and remove the switch control (4) from the transmitter. Remove the three-pole plug (5) from the socket (25) on the receiver. When

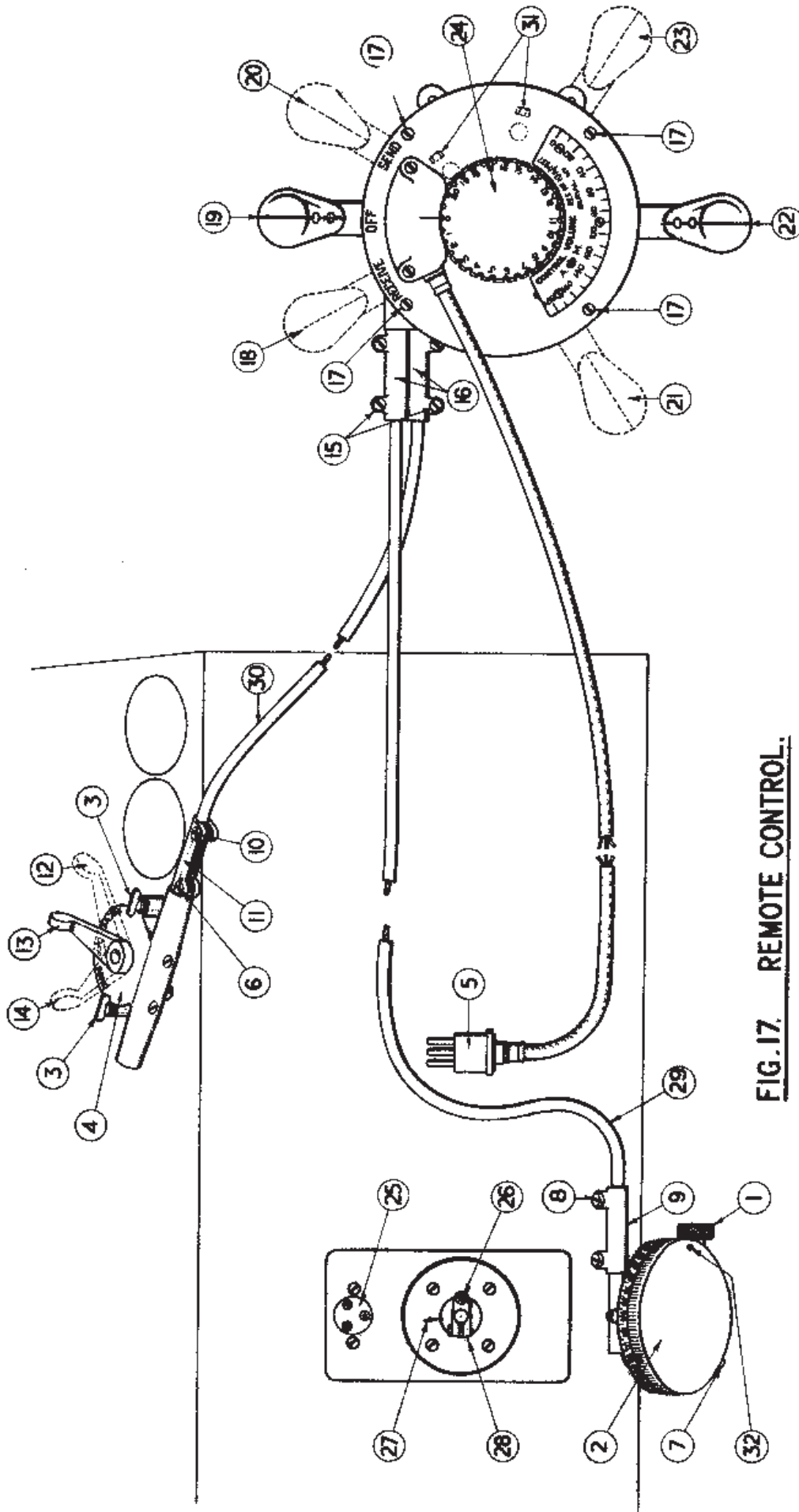


FIG. 17. REMOTE CONTROL.

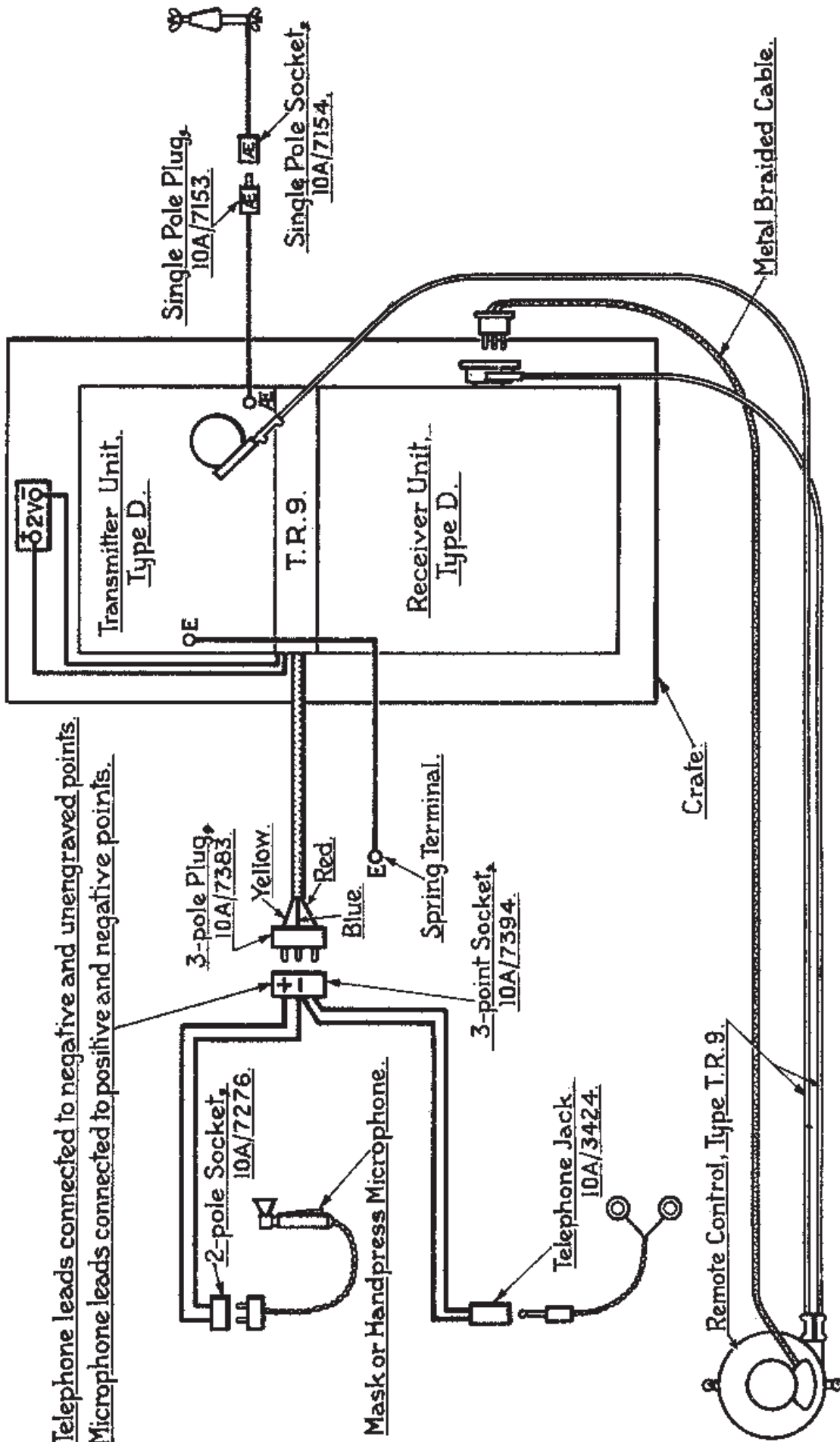


FIG. 18, INSTALLATION DIAGRAM OF TRANSMITTER - RECEIVER T.R. 9.

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re-connecting the condenser control, care is necessary to ensure that the head is fitted in the correct manner, *i.e.*, the scale on the head should indicate the correct position of the condenser vanes.

74. The clamp (28) is fitted on the condenser spindle in such a way that when the condenser vanes are at their zero position, the red spot (26) on the clamp is opposite the red spot (27) on the condenser case. When placing the head (2) in position, therefore, it is only necessary to rotate the condenser spindle until the two red spots are adjacent and, before engaging the dog in the head with the clamp, see that the zero graduation on the head is opposite the indicating line. A dimple (32) filled in with red enamel is provided on the top face of the head immediately above the zero graduation. It will be apparent from the position of the clamp (28) that the condenser vanes are at the 90 degrees position. The scale on the head is in the corresponding position and also the handle (22) on the controller. The condenser head is secured in position by means of the knurled screw (1).

75. In order to provide an alternative "lead-in" of the flexible shaft, in the event of the instrument being installed in an awkward position, the head is capable of being fitted in four different positions, 90 degrees apart from one another. A projecting stop pin on the inside of the condenser head prevents incorrect fitting of the head. It can be seated only when this pin is accommodated in one of the four notches cut in the edge of the condenser case. If desired, the clamp screw (1) may be removed and screwed into the reverse end of the clamp to allow access in any one of four different positions of the head.

76. A new system of remote controls known as Types C and D has been introduced for use with subsequent transmitter-receivers. Should it be necessary to install a T.R.9 instrument in an aeroplane equipped with either of these types an additional adaptor known as, "Adaptor, Condenser Coupling" (Stores Ref. 10A/9008) will be required in fitting the condenser control. The adaptor consists essentially of a split-ring clamping device which can be fitted to the condenser unit of the T.R.9 receiver unit, and to which the condenser unit handle of the type C or type D controls can be fitted.

77. As mentioned previously, once the controller flexible shafts have been correctly adjusted, no further adjustments are necessary. The following instructions are given for the information of personnel required to carry out initial fitting.

Initial assembly of send-receive switch

78. Remove the clamp (11) and thread the rack and flexible shaft through it. Hold the handle in its extreme position (14). Insert the rack through the guide and place it in mesh with the quadrant. Push the clamp (11) on the guide up to the shoulder and tighten the screw (6). Push the tube (30) through the clamp to its limit. Withdraw the tube approximately .05 in. and tighten the screw (10).

Initial assembly of condenser head control

79. Tighten the grip screw (7) and turn the condenser handle (2) clockwise (looking on face) to its extreme position. Hold the condenser handle (2) and push in the flexible shaft to its limit. Now slacken the grip screw (7), push the flexible shaft $\frac{3}{4}$ in. further and again tighten the grip screw (7). Push the tube (29) through the union (9) to its limit. Withdraw the tube approximately .10 in. and tighten the screw (8).

Initial assembly of controller

80. Remove the screws (17) and lift the volume control and cover. Tighten up the grip screws (31) and hold the handles in their extreme positions (18) and (23). Push in the

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flexible shafts to their limits. Now slacken the grip screws (31), push the flexible shafts $\frac{3}{4}$ in. further and again tighten the grip screws. Push the tubes through the unions (16) to their limits. Withdraw the tubes approximately .10 in. and tighten the screws (15). Replace the cover and volume control.

To synchronize the "zero" and "off" positions

81. Slacken the screws (15) and slide the tubes a little in the unions (16). Tighten the screws (15).

TRANSMITTER-RECEIVER T.R.11

(Stores Ref. 10A/8099)

82. The transmitter-receiver T.R.11 is similar in general design to the T.R.9, but it has a frequency range of 3,000 to 4,300 kc/s. and an additional facility is provided making inter-communication possible during transmission. It contains the transmitter unit type E (Stores Ref. 10A/8108) and the receiver unit type E (Stores Ref. 10A/8103). The details of the differences are given below.

83. In the receiver the L.T. + terminal is connected to the filaments of the first four valves only. The positive terminals of the second audio-frequency amplifier and of the output valve are both connected to a terminal on the contact bar designated L.T. + I/C., which takes the place of the earth terminal. The L.T. + I/C. terminal is connected through to a similarly designated terminal on the transmitter unit which is wired to a contact on the send-receive switch. This contact is connected, in the receive position only, to the L.T. + terminal. Thus during reception the first four valves receive their filament supply through the L.T. + terminal on the receiver, and the last two valves through the L.T. + I/C. terminals. A 2-pin plug is connected to the L.T. + and the L.T. + I/C. terminals of the main contact bar, and this is connected to a socket wired to a switch in the bomb-aiming position. By means of this switch the filaments of the last two valves can be supplied independently of the position of the send-receive switch. The H.T. contacts of the switch are so wired that H.T. + is connected to both receiver and transmitter in both the send and receive positions so that H.T. is available for inter-communication during either reception or transmission. The switch in the bomb-aiming position closes the filament circuit of the last two valves even if the send-receive switch is in the "off" position. It must, therefore, always be switched off when not actually in use.

84. The H.T.— and L.T.— circuits of the receiver are permanently connected to earth through the wiring of the transmitter so as to complete the circuit for inter-communication.

85. In the receiver, the I/C. terminal is connected through the condenser and resistance to the grid of the output valve instead of to the grid of the valve before the last as in the T.R.9. The value of the resistance in this lead is 0.25 megohms instead of 0.5 megohms, and a type 112 condenser (.0001 μ F.) is used instead of the type 121 condenser of the same capacitance.

86. The microphone, instead of deriving its supply from the positive lead to the valve filaments, is supplied from the L.T. + terminal through a separate contact on the switch, which closes the circuit in both the send and receive positions. The telephone connection is not switched from transmitter to receiver, but is permanently connected to the side-tone circuit in the transmitter as well as to the output of the receiver.

87. The plug-in coils for the receiver of the T.R.11 are similar in general construction to those for the T.R.9, but they are designed for the frequency range 3,000 to 4,300 kc/s. (range B) and are marked accordingly. The connections to the pins at the base of the coil are arranged to suit the wiring of the sockets, and differ from those of the T.R.9 coils.

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88. An extra resistance of 1,000 ohms (type 124) is mounted beneath the second anode coil, in the third compartment. This is connected in the H.T. lead to the second radio-frequency amplifier, between the H.T. + terminal and the second anode coil.

89. A resistance, type 113 (20,000 Ω), is mounted below the 3-pin socket for the volume control plug, and is connected in the lead to the positive of this socket. It is thus in series with the volume control potentiometer and limits the range of voltage on the screen grids of the first two valves to that in which stable operation is obtained. It also serves as a protective resistance, limiting the drain on the H.T. battery in the event of the earthing of the volume control potentiometer or leads.

90. The T.R.11 is designed for use with a different system of remote controls, known as the type C or type D, and the coupling on the spindle of the ganged condensers is therefore constructed to fit the condenser unit handle of these controls. The types C and D controls are described in the chapter dealing with T.R.11B.

91. Tuning is carried out exactly as for the T.R.9, except that a wavemeter W.75 will be used instead of the W.69 in tuning the transmitter. Typical settings for the T.R.11 installed in a small aeroplane with an aerial from wing tip to tail are given below :—

Frequency kc/s.	Aerial coil		Grid variometer	
	turns.	degrees.	degrees.	
4,388	1	180	60	
4,234	2	20	84	
4,074	3	20	84	
3,898	4	20	100	
3,744	5	20	106	
3,634	6	20	106	
3,525	7	20	118	
3,422	8	20	120	
3,333	9	20	150	
3,242	10	20	160	
3,178	11	20	160	
3,110	12	20	160	
3,046	13	20	180	
2,990	14	20	180	

92. An auxiliary condenser handle is available for local operation of the fine-tuning condensers either on the bench or in the aeroplane. It consists of a handle with a disc at the end carrying three pins and having two pins in the side of the handle. The three pins at the end, fit into the three holes in the index wheel attached to the end of the condenser spindle, and are used to control the condensers when the remote controls have been taken off. The two pins at the side, fit into holes in the condenser unit handle forming part of the remote controls, and these are used when the remote controls are fitted. One of these pins is detachable and is spring-loaded, so that the auxiliary handle will remain in place when the pins are inserted into the condenser unit handle.

93. A few T.R.11 transmitter-receivers have been modified for the transmission of telegraphy and are known as T.R.11A transmitter-receivers (Stores Ref. 10A/8544). The modification affects the transmitter only and the modified transmitter is known as the transmitter unit, type E (modified) (Stores Ref. 10A/8545). In the modified transmitter a 2-pin socket is fitted on the panel just above the control valve cover. The lead from the modulating choke to the send-receive switch is broken here and the two ends are connected to the tubes of the socket. For normal working a short-circuited plug anchored to the panel by a short length of cord is inserted into this socket and the transmitter then functions exactly the same as the T.R.11. When it is required to transmit C.W. telegraphy the short-circuited plug is taken out and a plug wired up to a transmitting key is inserted in its place.

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APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7917	Transmitter-receiver type T.R.9, consisting of:—		See under accessories for coils, etc., required.
10A/7918	Case		Fitted with contact bar, contact bar cover and plug.
10A/7931	Transmitter unit, type D.		
10A/7922	Receiver unit, type D.		
10A/7921	Tray, battery		Fitted with three contacts and four plugs.
	Transmitter unit, type D.		
	<i>Principal Components.</i>		
10A/7818	Ammeter, thermo		Reading 0 to 0.5.
10A/7932	Bar, contact		Fitted with 12 contacts.
10A/7911	Choke, H/F., type M.		
10A/7912	Choke, L/F., type G.		
10A/7933	Coil, aerial		Fixed in transmitter.
10A/3473	Condenser, type 24	1	.002 μ F, aerial.
10A/7386	" " 69	1	.0002 μ F, clip-in type.
10A/7387	" " 70	1	.0003 μ F, clip-in type.
10A/7388	" " 71	1	.001 μ F, clip-in type.
10A/7815	" " 113	1	.0005 μ F, clip-in type.
10A/7934	Cover	1	
10A/7266	Holder	2	For clip-in condensers.
10A/7913	Holder, valve, type E	2	
10A/7820	Milliammeter, type B	1	Reading 0 to 30.
10A/7153	Plug, type 29	1	Aerial.
10A/7914	Resistance, type 98	1	45,000 ohms grid leak.
10A/7915	Switch, type 69	1	Send-receive switch.
10A/7916	Transformer, microphone, type G	1	
10A/7935	Variometer, grid	1	
	Receiver unit, type D.		
	<i>Principal Components.</i>		
10A/7923	Bar, contact	1	Fitted with 7 contacts.
10A/7384	Choke, L/F., type B	1	Output choke.
10A/7387	Condenser, type 70	1	.0003 μ F, clip-in type.
10A/7388	" " 71	3	.001 μ F, clip-in type.
10A/7391	" " 74	1	2 μ F.
10A/7593	" " 85	8	.5 μ F.
10A/7814	" " 112	1	.0001 μ F, clip-in type.
10A/7900	" " 119	1	Miniature, variable, tubular.
10A/7901	" " 120	1	.001 μ F.
10A/7902	" " 121	1	.0001 μ F.
10A/7903	" " 122	4	.00005 μ F, clip-in type.
10A/7924	Cover	1	
10A/7925	Handle, condenser unit	1	
10A/7926	Holder, coil	3	Remote control.
10A/7266	Holder, resistance or condenser	4	
10A/7597	Holder, valve	6	
10A/7564	Mounting, resistance and condenser, type 1	2	
10A/7566	Mounting, resistance and condenser, type 3	2	
10A/7907	Mounting, resistance and condenser, type 7	1	
10A/9691	Plug, type 91	1	Engraved G.B. +.
10A/9693	Plug, type 93	1	Engraved — 1½.
10A/9694	Plug, type 94	1	Engraved — 3.

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Ref. No.	Nomenclature.	Quantity	Remarks.
10A/2312	Resistance, type 26	1	2 megohms.
10A/7267	" " 29	1	25 megohms.
10A/7316	" " 30	1	100,000 ohms.
10A/7600	" " 70	3	20,000 ohms.
10A/7602	" " 72	2	500,000 ohms.
10A/7603	" " 73	1	200,000 ohms.
10A/7908	" " 95	4	1 megohm.
10A/7910	" " 97	2	1.5 ohms, wire wound.
10A/7394	Socket, type 17	1	For remote volume control.
10A/7927	Condenser unit	1	Consisting of 3, type 123; 3, type 124; and 2, type 125.
<i>Accessories.</i>			
10A/7938	Case, transit.		
10A/7154	Socket, type 10.		
10A/7394	" " 17		Fitted in aeroplane for microphone and telephone connections.
10A/7928	Coil, aerial, Range A		6,000 to 4,300 kc/s for receiver.
10A/7929	" first anode, Range A		6,000 to 4,300 kc/s for receiver.
10A/7930	" second anode, Range A		6,000 to 4,300 kc/s for receiver.
10A/7939	Control, remote, switch and condenser.		
10A/7937	" " volume.		
10A/7936	" " T.R.9 complete		Consisting of above two items mounted together.
10A/7501	Coupling, switch		For type B casing and shafting.
<i>Stores for initial fitting.</i>			
5A/1386	Accumulator, 2 volt, 14 Ah		L.T. for transmitter and receiver.
5A/1383	Battery, dry, 4.5 volts	1	G.B. for receiver.
5A/1338	" " 15	1	G.B. for transmitter.
5A/1333	" " 120	1	H.T. for transmitter and receiver
10A/7738	Valves, V.R.21	3	Receiver.
10A/7813	" V.T.20	2	Transmitter.
10A/7607	" V.R. S.G.18	2	Receiver.
10A/7958	" V.R.22	1	Receiver (output)
10A/7503	Remote control casing, type B	—	$\frac{1}{8}$ in.
10A/7504	Remote control shafting, type B	—	$\frac{1}{8}$ in.
10A/7505	Remote control unions	—	With two screws for type B casing.
10A/8099	Transmitter-receiver type T.R.11, consisting of :—		
10A/8100	Case	1	Complete with contact bar and plugs.
10A/8103	Receiver unit, type E	1	
10A/8108	Transmitter unit, type E	1	
10A/7921	Tray, battery	1	
10A/8099	Transmitter-receiver type T.R.11, consisting of :—		
10A/8100	Case	1	Fitted with contact bar, contact bar cover, and one each type 48 and 52 plugs.
10A/8101	Bar, contact	1	
10A/7920	Cover, contact bar	1	
10A/8103	Receiver-unit, type E	1	
10A/8108	Transmitter-unit, type E	1	
10A/7921	Tray, battery	1	
<i>Accessories.</i>			
10A/8102	Case, transit	1	

December, 1938

Volume I

SECTION 2, CHAPTER 2

TRANSMITTER-RECEIVERS

T.R.9B, T.R.9C AND T.R.11B

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TRANSMITTER-RECEIVERS T.R.9B AND T.R.11B

(T.R.9B Stores Ref. 10A/9507)

(T.R.11B Stores Ref. 10A/9128)

INTRODUCTION

1. The transmitter-receivers T.R.9B and T.R.11B are almost identical instruments and are designed for use in aeroplanes to provide two-way R/T communication with the ground or with another aeroplane. The difference between them is in the frequency at which they operate and in the inter-communication facilities. Each consists of a two-valve radio telephony transmitter and a six-valve receiver contained in one case.

2. The T.R.9B contains the transmitter T.1102 and the receiver R.1103, and the T.R.11B contains the transmitter T.1098 and the receiver R.1099. The T.R.9B is primarily designed for use in single-seater aeroplanes; in such installations the instrument itself is inaccessible to the pilot and is entirely operated through a system of remote controls. The T.R.11B is primarily intended for use in bombers and is also operated by remote controls. The H.T. supply for both transmission and reception is provided by a battery housed inside the case, and the L.T. supply by an external 2-volt accumulator.

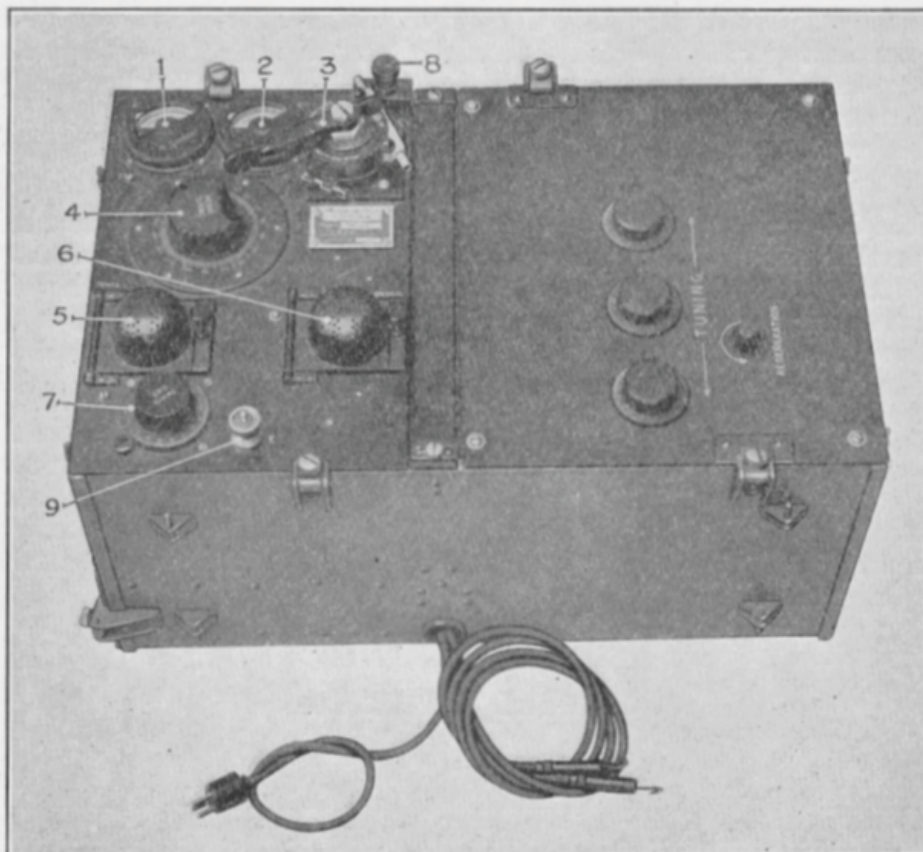


FIG. 1. Transmitter-receiver T.R.9B.

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3. Facilities are provided in both instruments for communication between the two occupants of two-seater aeroplanes during reception. In the T.R.11B inter-communication can also be carried out during transmission, but in the T.R.9B this is not possible.

4. The T.R.9B operates at any predetermined frequency between 4,300 and 6,000 kc/s, and the T.R.11B between 3,000 and 4,300 kc/s. Both instruments are designed to give a range of operation to the ground of about 35 miles and to another aeroplane of about 5 miles.

5. The overall dimensions of the instrument are approximately $19\frac{1}{2}$ in. by $13\frac{1}{4}$ in. by $9\frac{1}{2}$ in. and the weight excluding valves and batteries is $24\frac{1}{2}$ lb. With valves and dry batteries in place the weight is about 36 lb. The complete transmitter-receiver T.R.9B is shown in fig. 1. The T.R.11B is similar but has an additional flexible lead and plug.

6. The receiver unit and the transmitter unit are housed in a metal case, and from the combined instrument the necessary connections and controls are extended to a convenient position in the pilot's cockpit. At this position are situated the telephones for reception, the microphone for transmission, and the remote control with its three handles operating the send-receive switch, the receiver tuning condenser and the volume control of the receiver.

7. When the send-receive switch is in the "Send" position the aerial and earth are connected to the transmitters and the H.T. and L.T. connections and the microphone connections are made. The oscillator valve generates continuous oscillations and when the microphone is spoken into these are modulated at speech frequency, through the medium of the modulator valve, and radiation takes place at a frequency determined by the values to which the transmitter has previously been set, the speaker hearing at the same time his own speech in the telephones.

8. When the send-receive switch is in the "Receive" position the aerial and earth are connected to the receiver, the H.T. supply is again connected up and the L.T. supply is connected to the filaments of the receiver valves. Tuning of the receiver is effected by adjusting the tuning control of the remote controller. This operates the gang of three fine-tuning condensers, which give a small range on either side of the spot frequency to which the receiver has previously been adjusted. The volume of the output is controlled by means of a third handle on the controller, which varies the voltage applied to the screening grids of the two screen-grid valves in the receiver.

9. When the instrument is installed in a two-seater aeroplane the two microphones are connected in parallel and the secondary winding of the microphone transformer is connected through a condenser and resistance to the second audio-frequency valve of the receiver as well as to the modulator valve of the transmitter. When the last two valves of the receiver are operative, the speech of either occupant is amplified by them and is heard in both telephones, which are connected in parallel to the output of the receiver.

10. To make inter-communication possible during both transmission and reception, the microphone circuit and the H.T. supply to the receiver are connected in both positions of the send-receive switch. In the T.R.11B installation an additional switch at the bomb-aiming position is connected to the L.T. supply lead to the last two valves of the receiver, so that inter-communication may be obtained during transmission by closing this switch and thus rendering the two amplifying valves operative.

GENERAL DESCRIPTION

Transmitter

11. A theoretical diagram of the transmitter is given in fig. 2. V_1 is the oscillator valve and V_2 the modulator valve. The aerial circuit can be traced through the ammeter A, condenser C_3 , lower portion of the inductance L_1 , and condenser C_2 to filament circuit and earth. The circuit is tuned by means of a tapping S, which is rotatable within the coil L_1 . The anode circuit of the

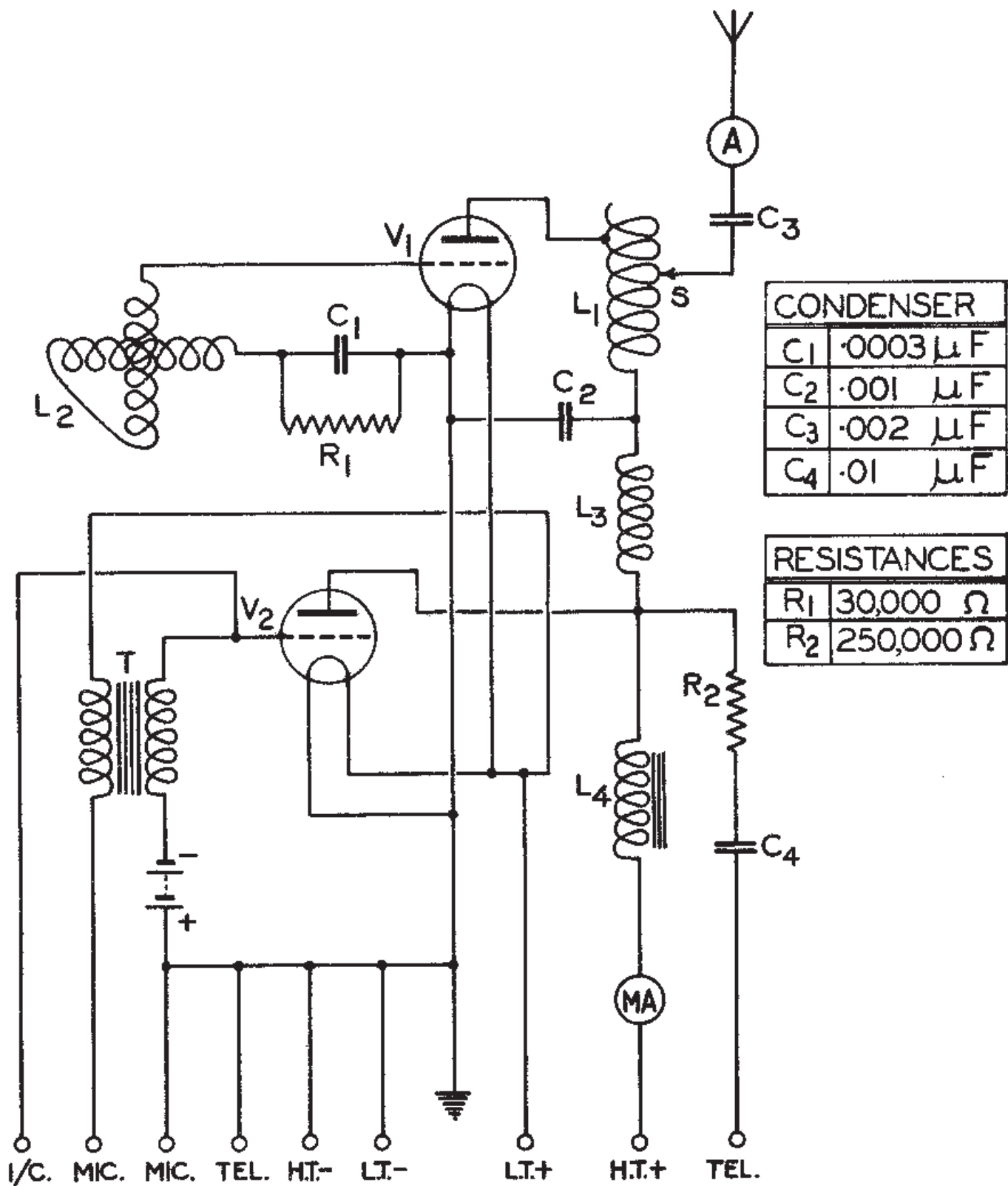


FIG 2 THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER UNITS

oscillator valve includes the inductance L_1 , and the H.T. supply is *via* the milliammeter MA, the low frequency choke L_4 , and the radio-frequency choke L_3 . In the grid circuit of the oscillator valve are the tuning variometer L_2 , the grid condenser C_1 and grid leak R_1 . The grid and anode circuits are arranged for minimum inductive coupling, radio-frequency oscillation being maintained by virtue of the anode-grid capacitance of the valve.

12. The modulator valve V_3 has its anode connected to the junction point of the radio-frequency choke L_3 and the audio-frequency choke L_4 , choke modulation being employed in the approved manner. The grid circuit of the modulator valve includes the secondary winding of the transformer T and a grid bias battery. One side of the primary winding of the transformer is connected to L.T.+, and the other end of the winding is connected *via* the microphone to L.T.—.

13. The transmitter incorporates a side-tone arrangement which enables the operator to hear, in his head telephones, the speech as radiated by the transmitter. This circuit can be traced from the anode of the modulator valve through the resistance R_2 and condenser C_4 , and *via* the telephones to earth.

Receiver

14. A theoretical circuit diagram is given in fig. 3. The receiver employs six valves. The first two are screen-grid radio-frequency amplifiers, and these are followed by a detector, two audio-frequency amplifying valves, and an output valve. Three tuned circuits are employed, each circuit being separately tuned by its individual variable condenser to the "spot" frequency. Across each of these main condensers is connected a small fine-tuning condenser, and these three are ganged together. The aerial is loosely coupled to the grid circuit of the valve V_3 through the condenser C_6 , and a static leak R_3 is connected from the aerial side of the condenser to earth. The inductance L_5 is connected in the grid circuit of the valve and is tuned by the condenser C_8 . The condenser C_7 is one of the ganged fine-tuning condensers referred to above. The negative lead of the valve filament includes the biasing resistance R_4 .

15. The screening grid of the valve is fed through the resistance R_5 with which is associated the decoupling condenser C_9 . The resistance is not connected directly to the H.T.+ line but terminates on one of the points of a three-point socket, of which another point is connected to earth and the third to H.T.+ through the resistance R_{19} . Variation of the screening grid voltage is accomplished by connecting, by means of a plug, a remote potentiometer R_6 . Movement of a contact over the resistance varies the screening grid voltage. The condenser C_{10} shunts the effective portion of the potentiometer and minimizes the noise produced by movement of the potentiometer. The anode circuit of the valve V_3 includes the inductance L_6 , which is tuned by means of a main condenser C_{12} and a ganged fine-tuning condenser C_{11} in a similar manner to the inductance L_5 . A further small fixed condenser C_{14} is connected between the variable condensers and the inductance for the purpose of opening out the tuning scale. The moving vanes of the two variables are earthed to prevent body capacity effects and, since the inductance is at H.T.+ potential, a blocking condenser C_{13} is inserted in the lead between the condenser and the inductance.

16. The anode of the valve V_3 is coupled to the control grid of the valve V_4 by means of the condenser C_{15} . A variable condenser C_{21} is connected between the anode of the valve V_3 and the anode of the valve V_4 . This acts as the regeneration control, no other regeneration device being employed.

17. The screening grid of the valve V_4 is fed through the resistance R_8 , with which is associated the decoupling condenser C_{16} . The potential of the screening grid is controlled simultaneously with that of V_3 . A biasing resistance R_8 similar to R_4 is inserted in the negative filament lead, and a grid leak R_7 is connected between the grid of the valve and earth.

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18. In the anode circuit of the valve V_4 is the third inductance L_7 , tuned by the condensers C_{17} and C_{18} . The tuning scale is opened out by condenser C_{20} . The moving vanes are again earthed and a blocking condenser C_{19} is provided to isolate them from the H.T.

19. The anode of the valve V_4 is coupled to the grid of the detector valve V_5 by means of the coupling condenser C_{22} , and a grid leak R_{10} is connected from the grid to L.T. — for rectification.

20. The anode circuit of the detector valve includes the resistance R_{11} , and an R/F. by-pass condenser C_{23} is connected between the anode and earth. The detector anode is coupled to the grid of the first audio-frequency valve by means of the condenser C_{24} , and included in the grid circuit is a stopper resistance R_{12} . The grid of the valve V_6 is connected to a grid bias lead through a resistance R_{13} .

21. The anode of the valve V_6 is fed through a resistance R_{14} , and is coupled to the succeeding grid circuit by the coupling condenser C_{25} . The grid of the valve V_7 is connected through the resistance R_{15} to the same grid bias tapping as the grid of V_6 . A second connection extends from the grid of valve V_7 through a resistance R_{18} and condenser C_{27} to a terminal marked I/C. This connection is provided to enable the valves V_7 and V_8 to be used, in addition to their ordinary functions, as amplifiers for inter-communication purposes, speech voltages from the microphone being impressed on the grid of the valve V_7 through the microphone transformer and the connection referred to above. The amplified speech is reproduced in the head telephones.

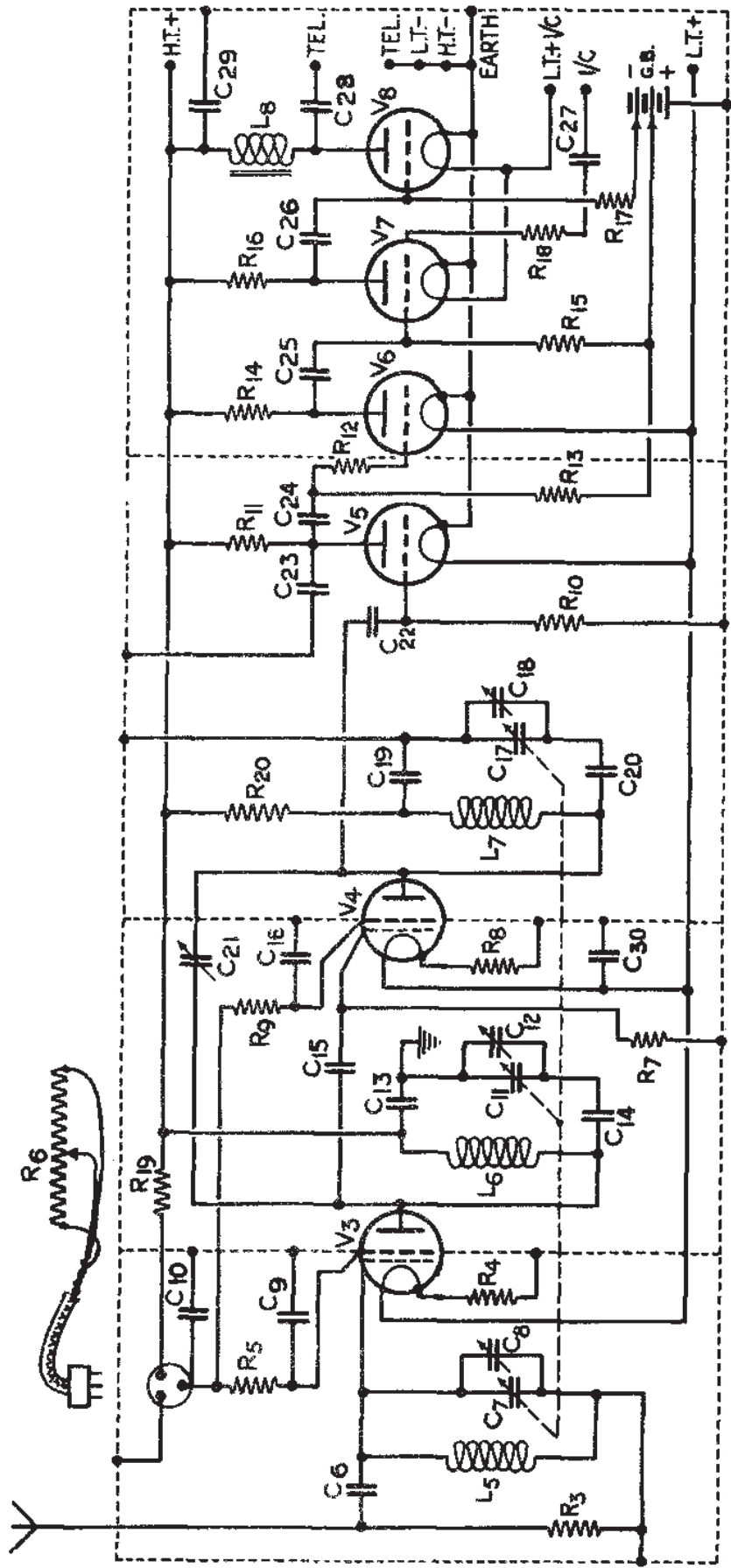
22. The coupling between the valves V_7 and V_8 is again by means of resistance and capacitance. The resistance R_{16} is in the anode circuit of V_7 and the anode is coupled to the succeeding grid by means of the condenser C_{28} . The grid of the last valve is separately biased, a connection being taken through the resistance R_{17} to a tapping on the grid bias battery. The anode circuit of the last valve includes the audio-frequency choke L_8 , and the telephones are connected from the anode through the condenser C_{29} to earth. A condenser C_{29} is connected from H.T. + to earth.

CONSTRUCTIONAL DETAILS

Transmitter unit

23. The transmitter unit and the receiver unit are both contained in the same case as shown in fig. 1, the transmitter being on the left-hand side. The components of the transmitter unit are mounted on the underside of a metal panel. The meters and controls are all mounted on the face of this panel and can be seen in fig. 1. At the top left-hand corner is the ammeter (1) for the aerial current. This is a thermo-ammeter reading from 0 to 0.5 amperes, and the thermo-couple is contained inside the instrument case. Adjacent to this is the H.T. milliammeter (2), which has a range of 30 milliamperes. Both these meters have the lower half of the dial protected with a fixed cover, and over this is a cover which can be turned to protect the upper half. The zero adjuster may be exposed by turning the outer cover. In the top right-hand corner of the panel is the send-receive switch, to which the remote control coupling (3) is attached as shown in the illustration.

24. Immediately below the meters is the aerial coil tuning handle (4) which controls the tapping on the coil, each revolution of the handle moving the contact by one turn. The number of turns in circuit is shown by a number displayed in a small window at the zero position of the graduated scale. The scale is marked in degrees and the inductance reading is thus given by the number representing the whole number of turns and the reading of the pointer on the degrees scale.



CONDENSERS μF					RESISTANCES OHMS				
C1		C10	.5	C19	.5	R1	In transmitter	R10	250,000
C2	In	C11	.00048 variable	C20	.01	R2	unit	R11	100,000
C3	transmitter	C12	.000233 variable	C21	10 μF	R3	.5 M Ω	R12	2 M Ω
C4	unit	C13	.5	C22	.0001	R4	1.5	R13	1 M Ω
C5		C14	.01	C23	.001	R5	20,000	R14	1 M Ω
C6	.00005	C15	.0003	C24	.001	R6	50,000 variable	R15	20,000
C7	.000048 variable	C16	.5	C25	.001	R7	1 M Ω	R16	200,000
C8	.000233 variable	C17	.000048 variable	C26	.001	R8	1.5	R17	1 M Ω
C9	.5	C18	.000233 variable	C27	.00003	R9	20,000	R18	500,000

FIG.3, THEORETICAL CIRCUIT DIAGRAM OF RECEIVER UNITS

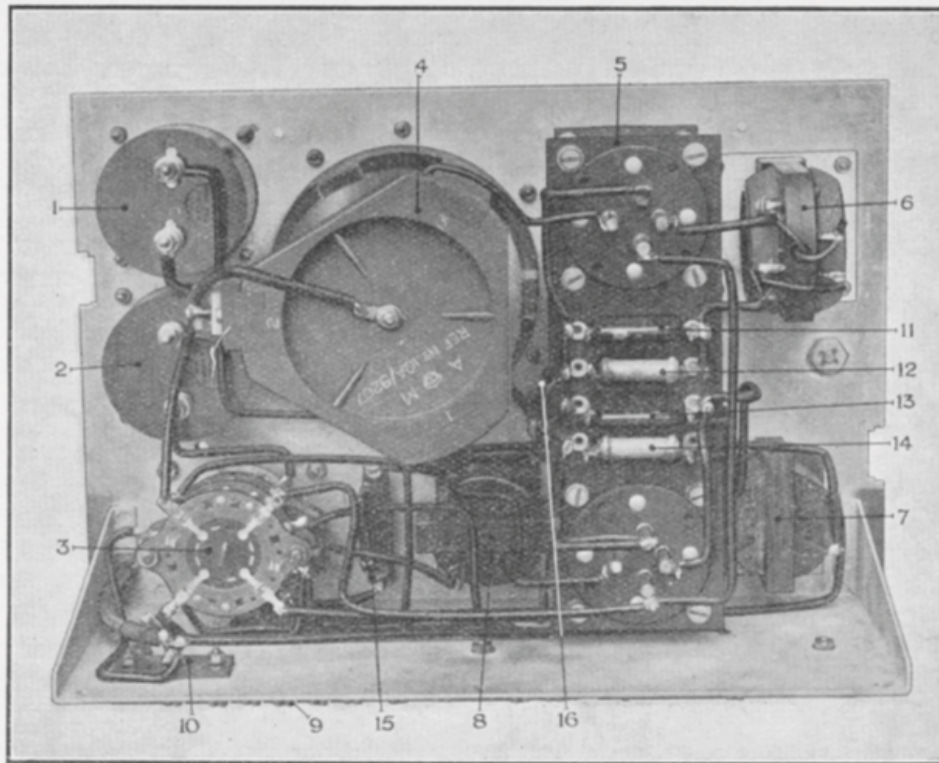


FIG. 4. Transmitter unit, underside view.

25. Below the aerial coil are two doors (5) and (6) giving access to the valves, the power valve being on the left and the control valve on the right. The valves are mounted below the panel, but are inserted through holes and protected by domed perforated covers hinged to the panel and secured by a milled thumb-screw. At the bottom of the panel is the control knob (7) for the grid variometer. A dial attached to the knob carries a scale graduated from 0–180°.

26. The only connections made from the front of the panel are those to the aerial and to earth. In the top right-hand corner of the transmitter is shown the aerial terminal (8). In some models no aerial terminal is fitted, but a flexible lead passes through the panel and terminates in a plug for insertion into a socket connected to the aerial. The earth terminal (9) is mounted directly on the panel.

27. The underside of the transmitter unit is shown in fig. 4. The aerial ammeter and the H.T. milliammeter are seen at (1) and (2), the send-receive switch at (3) and the aerial coil at (4). The valve-holders are mounted on a small panel (5) carried on four pillars, two resistances and two condensers also being mounted on this panel. The grid variometer (6), microphone transformer (7), and modulating choke (8) are mounted directly on the front panel. The contact bar (9) is mounted on an angle plate at the side of the transmitter; it carries twelve spring contacts which engage with the knife contacts on the fixed contact bar when the transmitter is in position. A terminal (10) is used on most of the transmitters issued, for connection of the flexible aerial lead when this passes through the panel.

28. The send-receive switch (3) is built up of three flat units. Each unit consists of an insulating plate with fixed contacts attached to it in the required positions, and a rotating disc in the centre carrying contact points. These points pass through the disc and make contact with a ring or part ring at the back attached to the disc in the same manner as the fixed contacts, and have a projecting soldering lug. A strip attached to the control knob and turning with it passes through a slot in each central disc so that movement of the knob

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turns all three discs and the contact points attached to them. The fixed contact points are arranged so that the required connections can be made. The arrangement of the three switch units is shown in fig. 7 and the connection to each terminal is indicated. The upper part of the figure shows the switch in the "receive" position and the lower part in the "send" position. From these figures it will be seen that all the connections shown in fig. 5 are made in the two positions of the switch.

29. The aerial inductance (4) consists of a helical coil of copper tube carried on a frame of insulating material. The tapping contact consists of two spring blades mounted on a nut working on a brass screw fixed in the centre of the coil. The pitch of the screw corresponds to the pitch of the coil and the screw is surrounded by a sleeve of insulating material slotted throughout its length to allow the contacts to move axially. The sleeve turns with the handle and the contacts thus travel along the entire length of the copper tube. The position of the contact on the tube is indicated by the figure and scale reading on the front of the panel as already described.

30. Two condensers (11) and (13) and two resistances (12) and (14) are mounted on the sub-panel (5). The $0.0003 \mu\text{F}$ condenser (11), and the $30,000 \Omega$ resistance (12), are connected in parallel between the grid variometer and the filament of the power valve. The $0.001 \mu\text{F}$ condenser (13), is the main oscillating condenser. The $25\text{M} \Omega$ resistance (14) is connected in series with the $0.01 \mu\text{F}$ condenser (15), mounted on the panel, and the two are in the lead forming the connection to the telephones for side-tone purposes. The radio-frequency choke (16), mounted underneath the sub-panel (5), is connected between the audio-frequency choke and the aerial coil. The bench wiring diagram of the transmitter units is given in fig. 6.

Receiver unit

31. The receiver unit is fitted into the right-hand side of the case as shown in fig. 1. A view of the upper side of the unit with the screening cover removed is given in fig. 8. Nearly all the components are mounted on a metal panel, some being above and some below. The screening box (1) contains the three independent variable condensers (2), (3) and (4) corresponding to the condensers C_8 , C_{12} and C_{18} in fig. 3, and the three ganged condensers corresponding to C_7 , C_{11} and C_{17} for fine tuning. The condensers (2), (3) and (4) have each a knob and dial marked in degrees from 0–180, which project through the upper panel for adjustment of the frequency range. The screening box is divided into three sections and a $0.01 \mu\text{F}$ condenser, corresponding to C_{20} in fig. 3, is mounted inside the section containing condenser (4). The three coils (5), (6) and (7) are mounted close to the condenser box and each is covered with a screening box. The six valves are also mounted on the upper side of the panel. Valves (8) and (9) are the screened grid valves for radio-frequency amplification, each being in a separate screened compartment. The regeneration control condenser (10) is mounted close to the second valve on the side of the condenser box and has a control knob projecting through the upper panel. The detector valve (11), the two audio-frequency amplifiers (12) and (13) and the output valve (14) are arranged in order. A small side panel (15), of which the front view is shown in fig. 9, carries the socket to which the volume control rheostat is connected and also the socket for the remote tuning control. The $2 \mu\text{F}$ condenser connected between H.T. + and earth is also mounted behind this panel. The grid bias battery (16) is fitted into clips by the side of the panel supports.

32. The space underneath the panel is about 2 in. deep and is divided by screens into four compartments as shown in fig. 10. In the left-hand compartment, over which the first R/F. valve and the aerial coil are mounted, is a mounting plate (1) carrying a condenser and two resistances. The $0.00005 \mu\text{F}$ condenser couples the aerial to the first tuned circuit, and the adjacent $5\text{M} \Omega$ resistance is connected between the aerial and earth. The other resistance is connected in series with the screen grid. The condenser (2) at the side of the compartment is a decoupling condenser connected between the screen grid and earth. Close to the valve socket is the 1.5Ω resistance (3), connected in the filament circuit to provide grid bias.

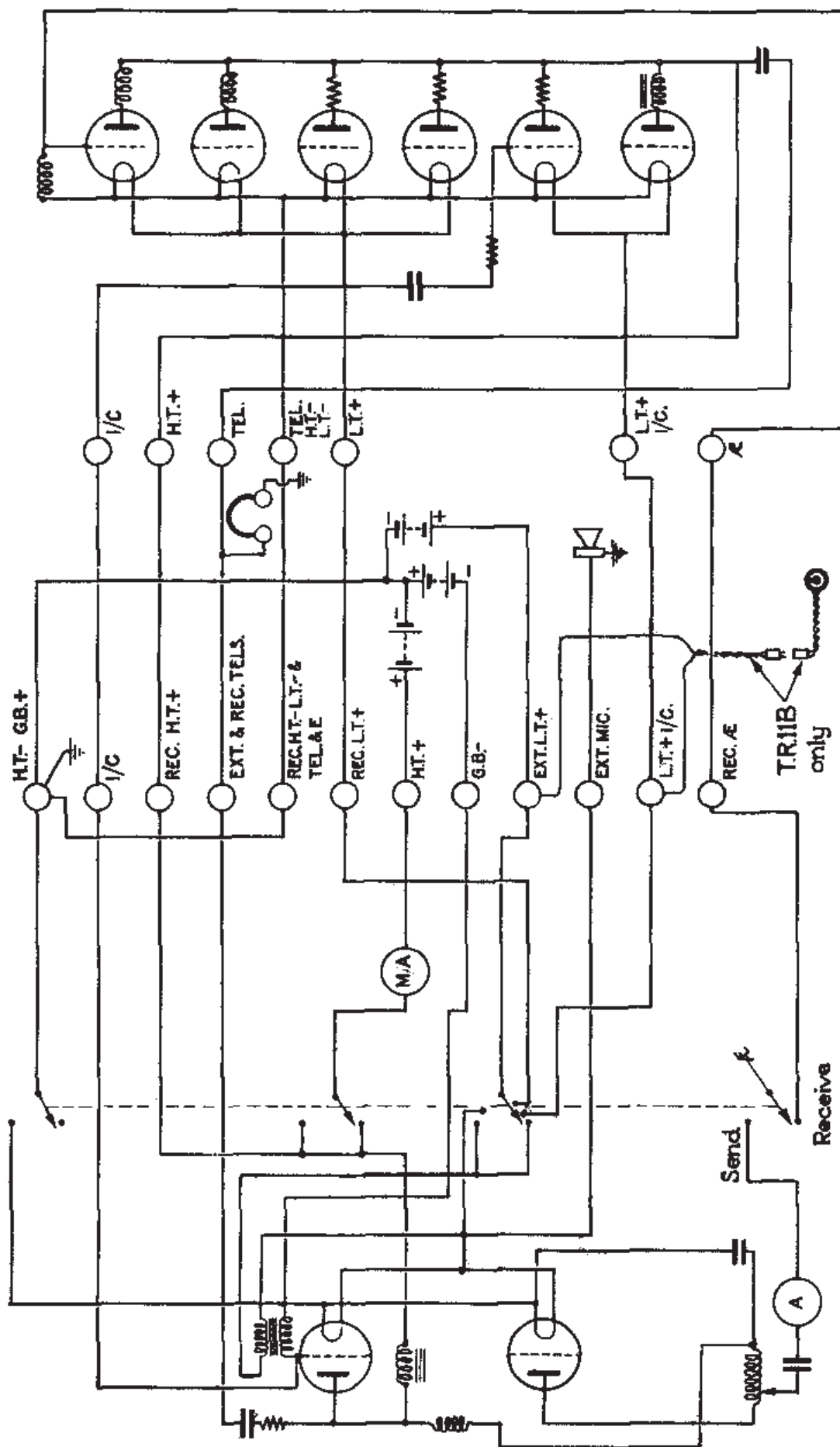


FIG.5. TRANSMITTER-RECEIVER DIAGRAM
TR9B AND TR11B

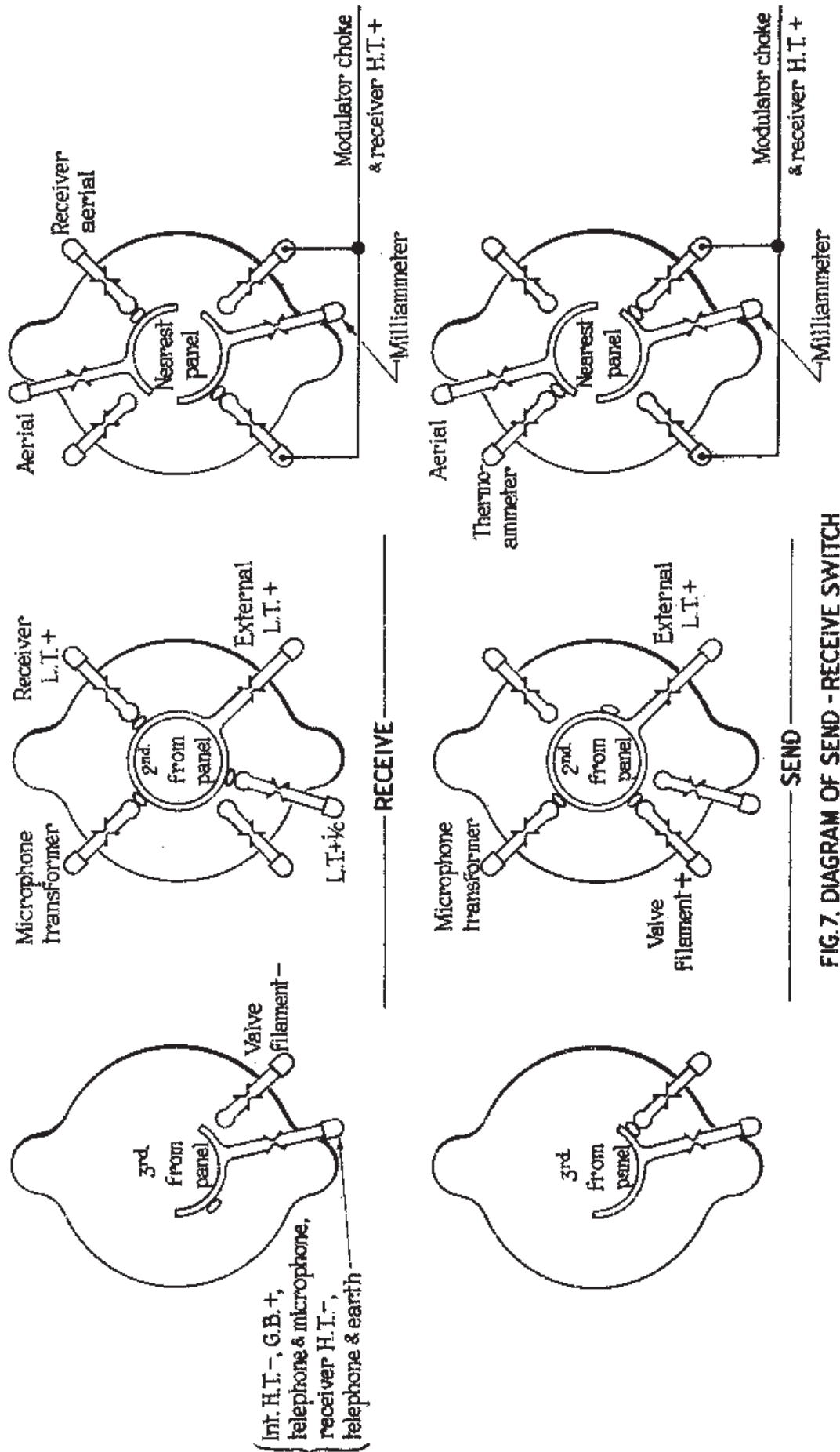


FIG. 7. DIAGRAM OF SEND - RECEIVE SWITCH

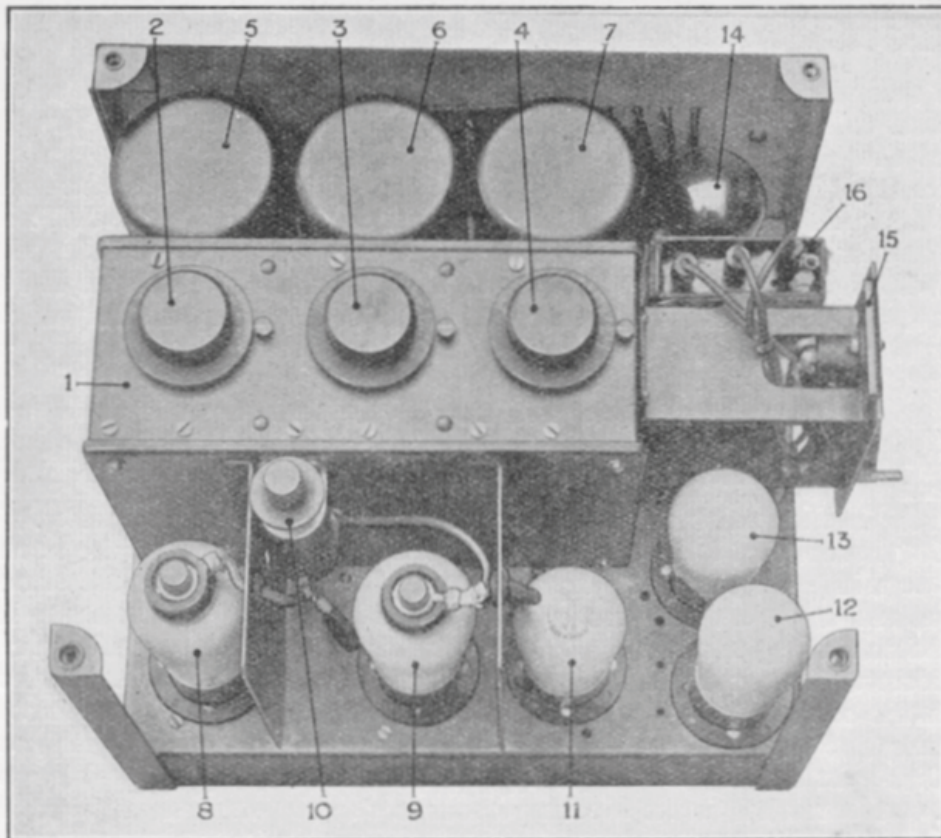


FIG. 8. Receiver, cover removed.

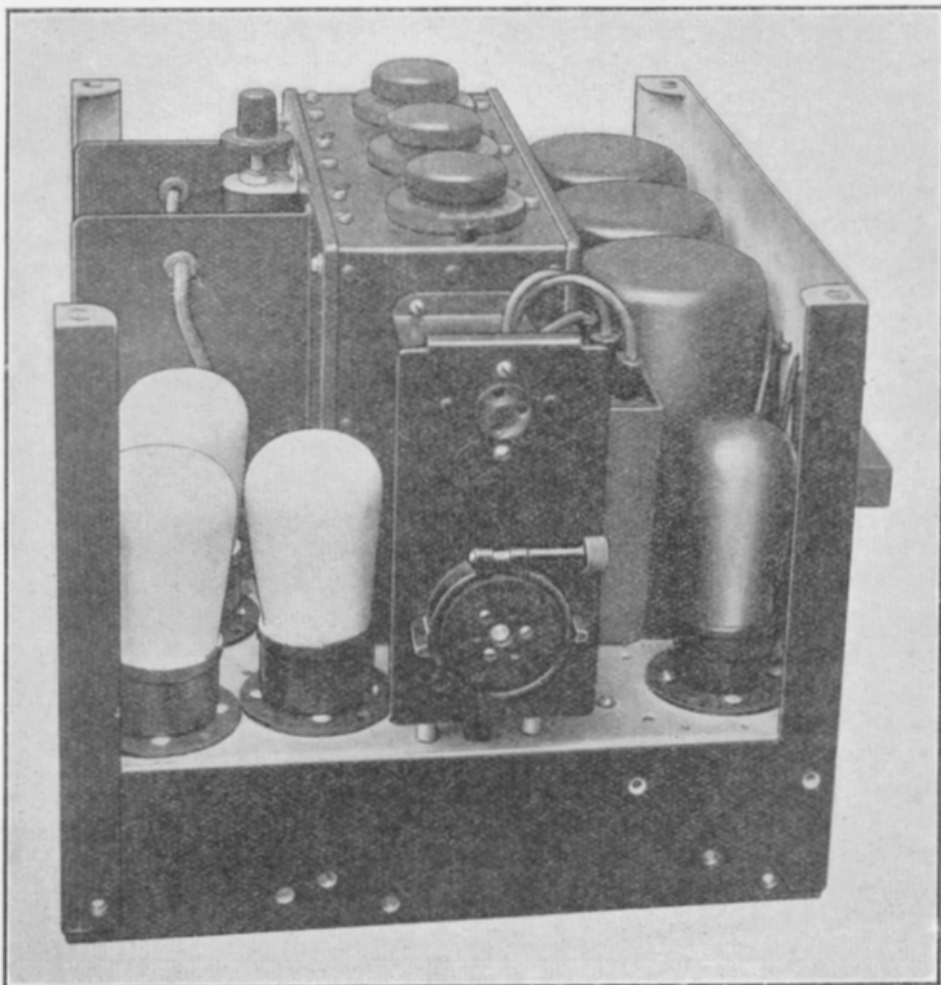


FIG. 9. Receiver, end view, cover removed.

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33. In the second compartment the resistance (4) is connected in the same manner for biasing the second valve. The $\cdot 5 \mu\text{F}$ condenser (5), is the decoupling condenser for the second screen grid, and the $\cdot 01 \mu\text{F}$ condenser (6), below this is connected between the positive end of the filament and earth. Three resistances and two condensers are mounted on the insulating plate (7). The first resistance ($20,000 \Omega$) is connected in series with the H.T. supply to the volume control potentiometer. The adjacent resistance ($20,000 \Omega$) is in series with the second screen grid, and the third resistance ($1 \text{ M}\Omega$) is the grid leak for the second R/F. valve. The condenser next to this ($\cdot 003 \mu\text{F}$.) is the coupling condenser between the first and second valves, and the end condenser ($\cdot 01 \mu\text{F}$.) is the scale-opening condenser in the second tuned circuit. The condensers (8) and (9) (both $0\cdot 5 \mu\text{F}$.) are the decoupling condenser, connected to the volume control socket, and the blocking condenser in the second tuned circuit respectively.

34. In the third compartment, over which the third tuned coil and the detector valve are mounted, is a mounting plate (10) fixed on the side. Nearest the panel on this plate is a resistance ($1 \text{ M}\Omega$) in the grid bias lead to the first audio-frequency amplifier. The adjacent resistance ($2 \text{ M}\Omega$) is connected as a stopper resistance in the grid lead to the same valve. The condenser next to this ($\cdot 001 \mu\text{F}$.) is the coupling condenser between the detector and first audio-frequency valve, and the other condenser ($\cdot 001 \mu\text{F}$.) is connected between the detector anode and earth. The remaining resistance ($100,000 \Omega$) is the decoupling resistance in the H.T. lead to the detector. The mounting plate (11) carries the $\cdot 0001 \mu\text{F}$ coupling condenser connected between the second radio-frequency amplifier and the detector, and also the $\cdot 25 \text{ M}\Omega$ resistance forming the grid leak of the detector. The mounting plate (12) carries a single resistance ($2,000 \Omega$) in series with the H.T. supply to the second radio-frequency amplifier, and the $\cdot 5 \mu\text{F}$ condenser (13) is the blocking condenser separating the tuned condensers of the second anode from the H.T. potential.

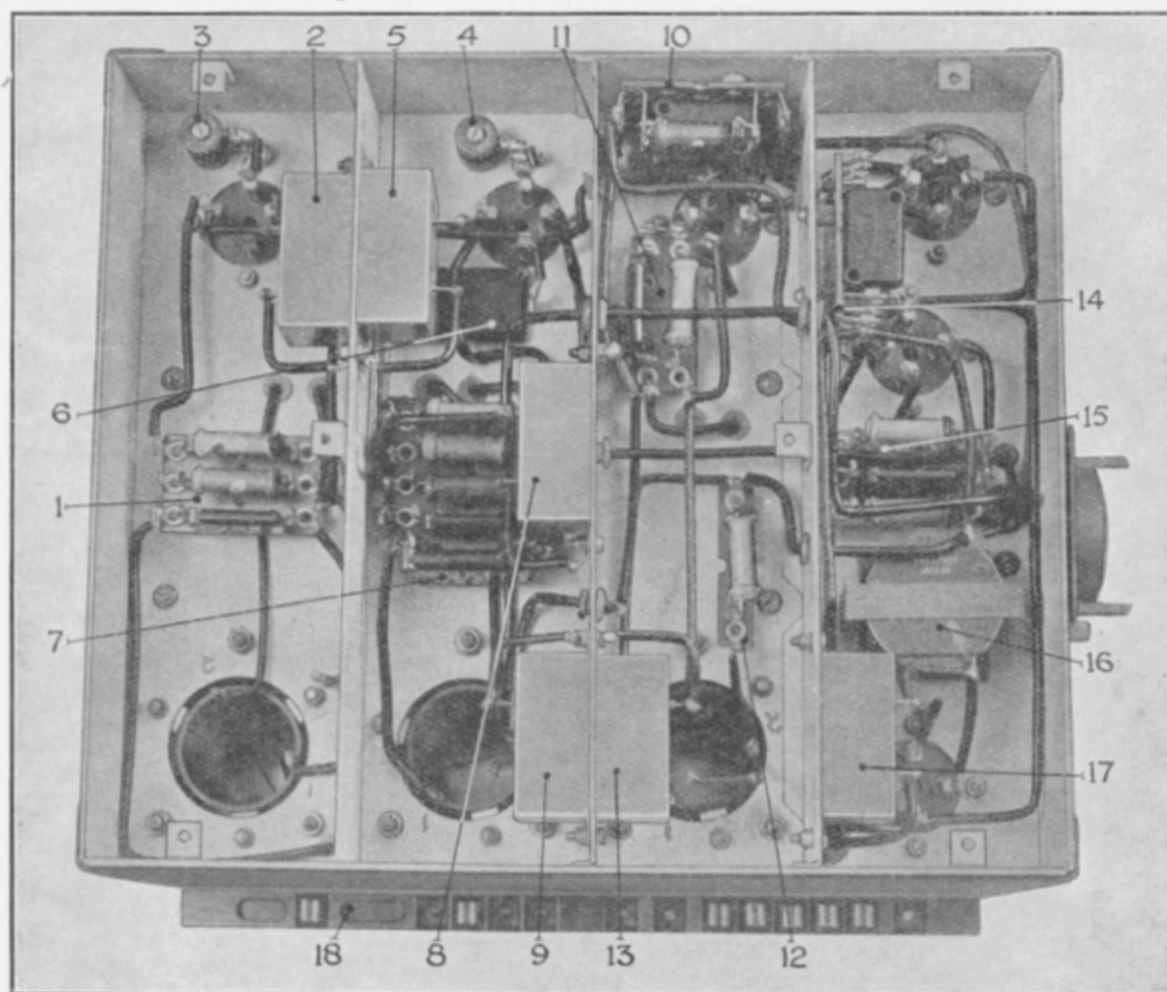


FIG. 10. Receiver, underside view.

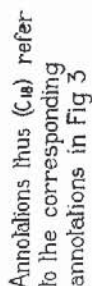


FIG. 11. BENCH WIRING DIAGRAM OF RECEIVER UNITS

35. The right-hand compartment contains the audio-frequency amplifying circuit. The mounting plate (14) fixed to the side carries two condensers and three resistances. The resistance nearest the panel ($1\text{ M}\Omega$) is in the grid bias lead to the second audio-frequency amplifier. Next to this is the coupling condenser ($\cdot 001\text{ }\mu\text{F.}$) between this and the preceding valve; next is a $20,000\text{ }\Omega$ resistance in the H.T. lead to the first audio-frequency amplifier, and at the end are the resistance ($\cdot 5\text{ M}\Omega$) and condenser ($\cdot 00003\text{ }\mu\text{F.}$) connected in series to the grid of the second audio-frequency amplifier to form the input circuit for inter-communication. In the centre of the compartment is a mounting plate (15). The upper resistance on this ($200,000\text{ }\Omega$) is in the H.T. supply to the second audio-frequency amplifier. The $\cdot 001\text{ }\mu\text{F.}$ condenser couples this valve to the grid of the output valve, and the other resistance ($1\text{ M}\Omega$) is in the grid bias lead to the output valve. The audio-frequency choke (16) and the $\cdot 5\text{ }\mu\text{F.}$ condenser (17), form the choke-capacitance coupling between the output valve and the telephones.

36. The bench wiring diagram of the receiver unit is given in fig. 11. All the connections to the receiver except those of the remote volume control are made by means of spring contacts mounted on the contact bar (18), which engage with knife contacts mounted on a contact bar fixed in the case.

Case

37. The transmitter and receiver units are housed together in a special case. They are shown in position in fig. 1, and in fig. 12 the case of the T.R.11B is shown with the units removed. The case is of metal and is painted grey. The case of the T.R.9B is similar but the lead and plug on the left are not fitted. A main contact bar, shown in fig. 12, is fitted in the case, and from the underside of the contacts flexible connections are taken out through a bush. When

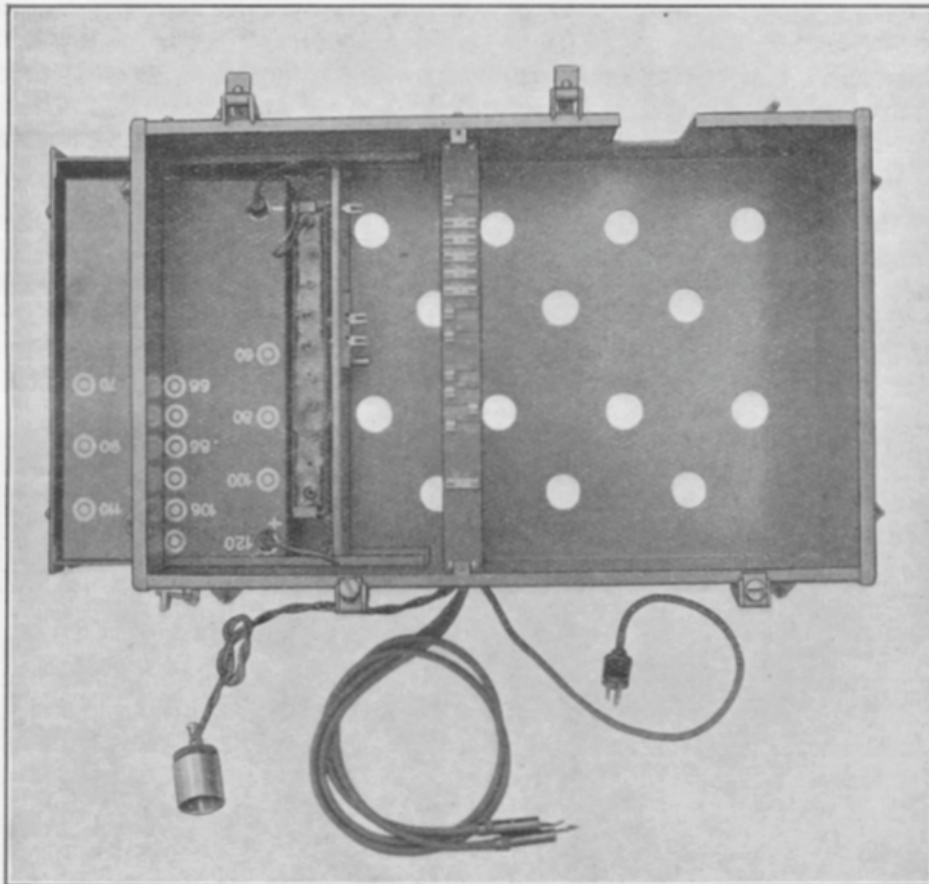


FIG. 12. Case of T.R. 11B.

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the units are in position, spring-jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads terminating in plugs the batteries are connected up to three spring-jaw contacts on the tray, and when the tray is in position these three contacts engage with three knife contacts on the underside of the main contact bar.

38. In fig. 13 the engravings near the various contacts are clearly shown. The transmitter contact bar and receiver contact bar are shown disengaged from the main contact bar, and on the left is the tray also partly withdrawn. The tray passes under the transmitter contact bar.

Transit case

39. A transit case is provided for carrying the transmitter-receiver. It is constructed of yellow deal and is painted grey. The dimensions are approximately 1 ft. 9 in. by 1 ft. 3 $\frac{3}{4}$ in. by 10 $\frac{3}{4}$ in., and the case accommodates the complete instrument. The hinged lid is fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROLS

40. The T.R.9B and T.R.11B transmitter-receivers are intended for operation by remote controls, and three different adjustments are made by these controls. The send-receive switch and the fine-tuning condensers are each operated by a flexible shaft running in a casing and actuated by a wheel and handle. The volume is regulated by means of a potentiometer connected by a cable to the receiver in such a manner as to vary the potential applied to the screening grids of the two radio-frequency amplifiers. The three controlling handles are mounted in one unit known as the controller.

41. Two types of remote control, the type C and the type D, are standardized for use with these instruments. The type C remote controls have a flexible shaft of $\frac{5}{8}$ in. diameter for both the switch control and the tuning control. The type D remote controls are intended for installations where the shafting is 15 ft. long or more, and in this type the flexible shafting for the switch control is $\frac{3}{16}$ in. in diameter, the tuning control using the $\frac{5}{8}$ in. shafting as in the type C remote controls. Larger casing is therefore used for the type D controls, and the controller and switch coupling are modified to accommodate the larger shafting.

42. The types C and D remote controls, as applied to the T.R.9B and T.R.11B are shown in fig. 14. The controller (11) is mounted in the pilot's cockpit; the switch coupling (23), condenser unit handle (29) and the plug (26), are fitted to the transmitter-receiver. The flexible shafting (1) runs in a casing, part of which is rigid (8) and part flexible (16) and (30). The shafting consists of a stranded core of steel wire on which is wound a helical tooth wire making about ten turns to the inch.

43. The controller consists of two parts fitted together. One part, known as the Control, switch and tuning, consists of the mechanism for operating the two flexible shafts for the send-receive switch and the tuning condensers. The other part, the volume control, is mounted in the centre of the switch and tuning control and consists of a high resistance potentiometer operated by a knob.

44. The switch and tuning control consists of a case containing two wheels (3) with teeth specially shaped to engage with the helical tooth on the flexible shafting, so that rotation of the wheel moves the shafting in one direction or the other. The longer handle (5) is connected to the

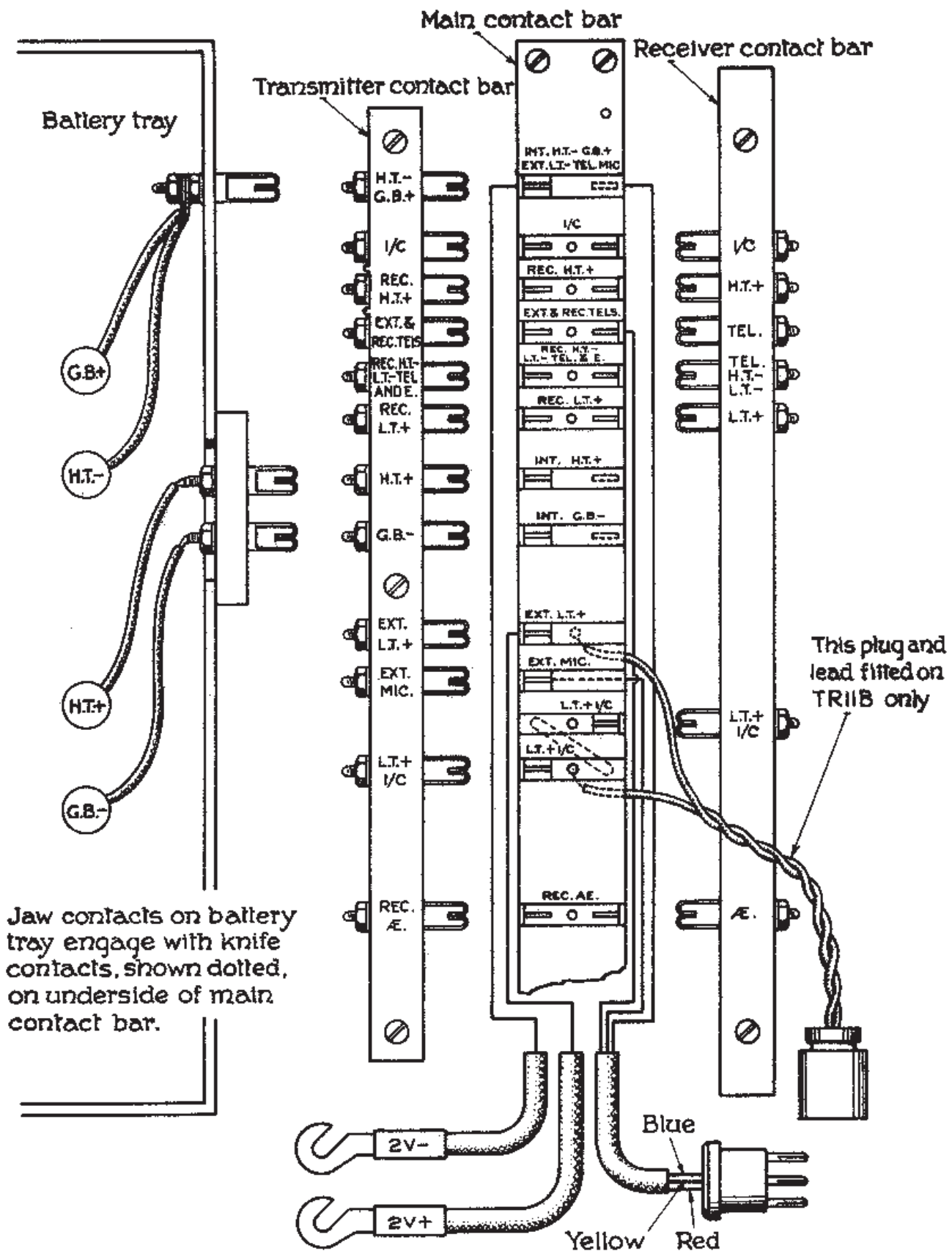


FIG. 13, TRANSMITTER-RECEIVERS T.R.9B AND T.R.11B
CONTACT BAR CONNECTIONS

wheel engaging with the flexible shafting in the guide tube (12) and is the control for the send-receive switch. The other handle (13) is connected to the other wheel, and this meshes with the flexible shafting in the guide tube (2). This shafting is connected to the tuning condensers and the handle (13) thus forms the tuning control.

45. Each handle is attached to a lever by a single screw. Three holes are provided in the switch control handle, and two in the tuning control handle, so that adjustment of the effective length of the levers is available. A spring-loaded catch (4) is fitted on the switch control handle. The central position of this handle is the "off" position, and it can be locked in this position by engaging the catch with a notch in the frame.

46. The guide tubes are attached to the body of the controller by two screws each (6), and are arranged so that if one screw is removed and the other loosened the guide tube may be swung away from the toothed wheel and the flexible shaft thus disengaged. The controller may be mounted with either of the handles uppermost, and the engraving is duplicated so that it can be read in either position. The flexible shaft may be arranged to enter either side of the controller, and the two extreme positions of the handle may be allotted for "send" and "receive" to suit the installation. The words SEND and RECV. are engraved on detachable plates which can be interchanged and turned upright to show the positions of the handle for the corresponding positions of the switch in the instrument.

47. The switch coupling (23) also contains a wheel with teeth to engage in the helical winding on the flexible shaft. On the lower end of the spindle carrying this wheel is a dog, which fits over the cross-bar attached to the switch spindle on the instrument. A handle (19) is fitted on to the outer end of the shaft for local operation of the switch and as a local indicator of the switch position. As in the controller, the guide tube (25) is fixed by two screws (17), either of which may be removed to disengage the flexible shaft from the wheel.

48. The switch coupling fits on to a ring adaptor (24) which is attached to the transmitter panel by two 2 B.A. countersunk screws $\frac{1}{4}$ in. long. The sleeve and flange of the coupling are slit and are clamped up on the adaptor ring by tightening the screw (22) which draws up the band round the sleeve. A key inside the sleeve engages in a keyway in the upper edge of the adaptor ring. The ring has eight keyways equally spaced so that the coupling can be secured in any of eight positions on it to allow the casing and flexible shaft to be led up to the instrument at the most convenient angle. The shaft may be led off from either end of the guide tube provided that the controller is arranged accordingly.

49. The handle (19) may be fitted on to the square end of the spindle in any of eight positions, and is secured by the screw (18) with a locking washer. The plate (21) is cut away to form a stop plate and also carries the designations S and R to indicate the "send" and "receive" positions. This plate can also be fixed in eight different positions to suit the position chosen for the handle. It is located by a dowel pin and secured by the nut (20) with its locking washer. The reverse side of the stop plate is also engraved S and R, but in the reverse positions. The reverse engraving will not, however, be required when the coupling is fitted to these transmitters.

50. The condenser unit handle (29) consists of a knob fixed to a spindle turning in the body. A disc is fixed on the other end of the spindle inside the body and carries a single eccentric pin which engages in the largest of the three holes in the index wheel (28) attached to the operating spindle of the gang of fine-tuning condensers. The guide tube for the flexible shafts attached to the body by two screws, in the same way as in the switch coupling, and the flexible shaft meshes with a wheel on the spindle. The sleeve of the body fits inside the split ring (32) fixed to the receiver, and is clamped by the screw (27). The condenser unit handle can be fixed in any position in the ring. A dial engraved with a scale of 0-180° on each half, forms part of the knob. One scale is marked in white and the other in orange, and the two indices (31) register with them. Whichever scale is more easily visible may thus be used. One end of the guide tube is coloured red and the other green, and the ends of the guide tube on the controller are also marked with these colours. The flexible shaft must be led off from the red end of both or the green end of both in order to obtain the correct direction of rotation of the condenser.

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51. The rigid casing (8) for the flexible shaft consists of solid-drawn light alloy tubing. The flexible case (16) and (30) is built up of a helix of brass strip over which is a winding of steel wire and another of phosphor-bronze or spring steel wire, and finally, a waterproof covering of varnished cotton braid. The junctions between the casing and the components and between two lengths of casing are made by means of casing unions (7). The free ends of the shafting at the controller, the switch coupling, and condenser unit handle are protected by short lengths of rigid casing fitted to the free ends of the guide tubes by casing unions, and pinched up at the ends.

52. The union consists of two split clips made in one piece, and each clip is clamped up on the casing by means of a screw. A hole is drilled through the union at each end to take a key pin for increased security. These pins are not fitted, however, in the unions at the free ends. Special unions (15) to allow of lubrication are fitted between the flexible and the rigid casing, and along the run of the rigid casing when necessary. These lubricator unions carry a standard grease nipple, and have a union nut at each end. The union nut is tightened up on to a cupped washer inside the body, which is thus flattened out and bites into the tubing.

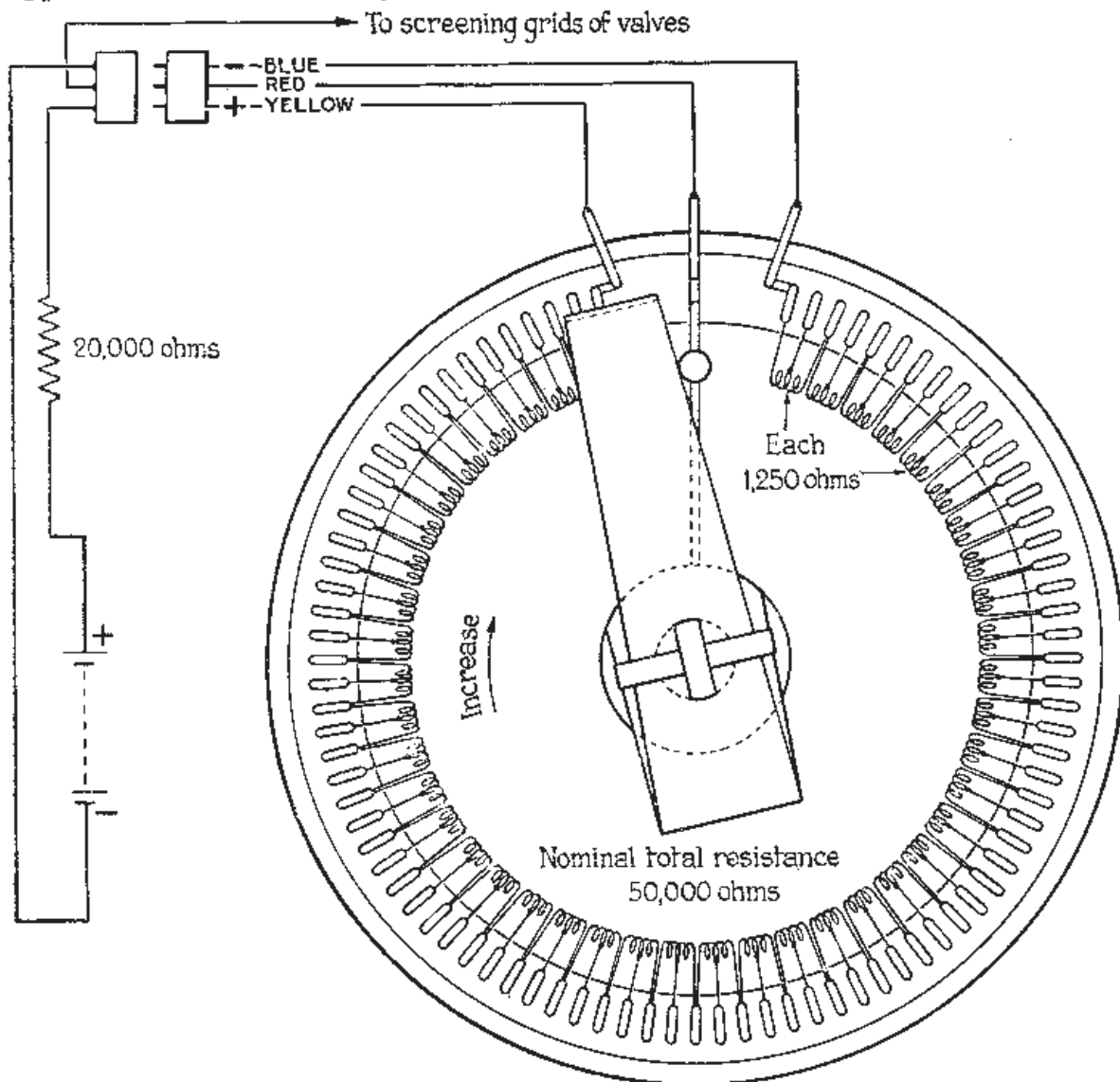


FIG.15. VOLUME CONTROL CIRCUIT

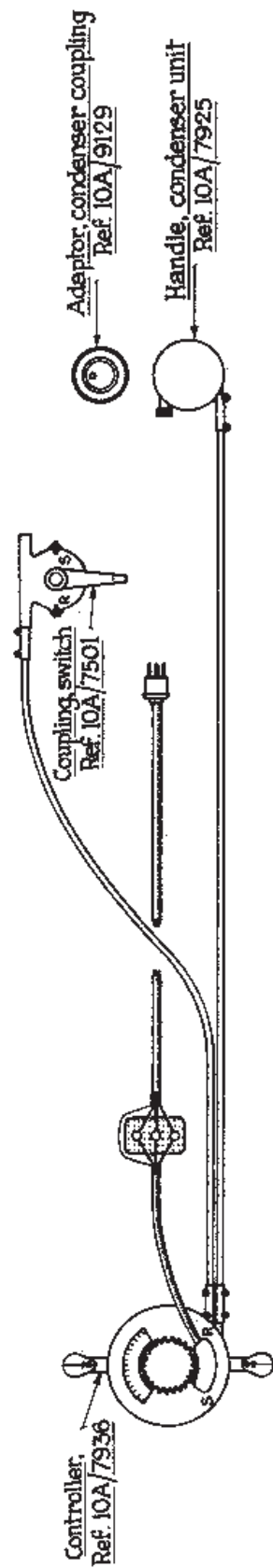
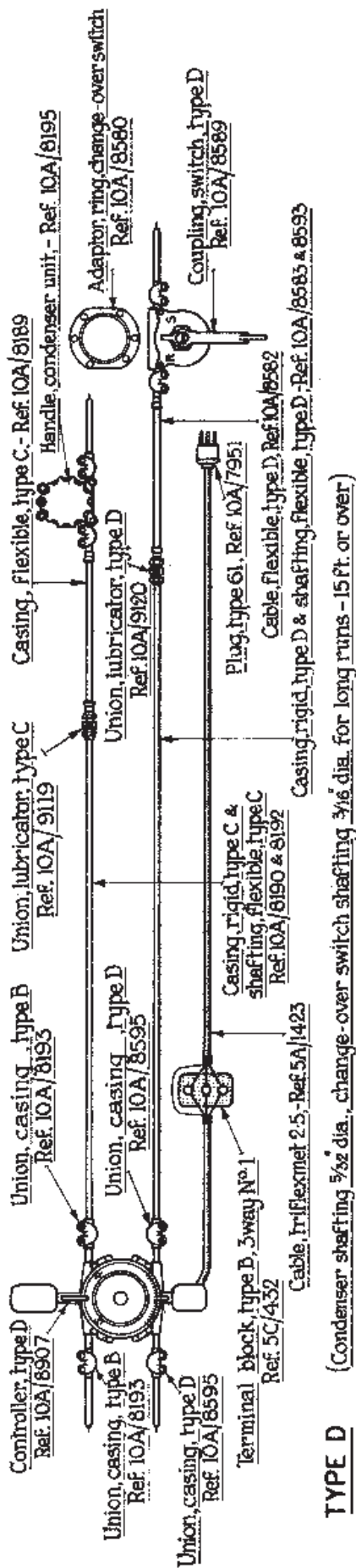
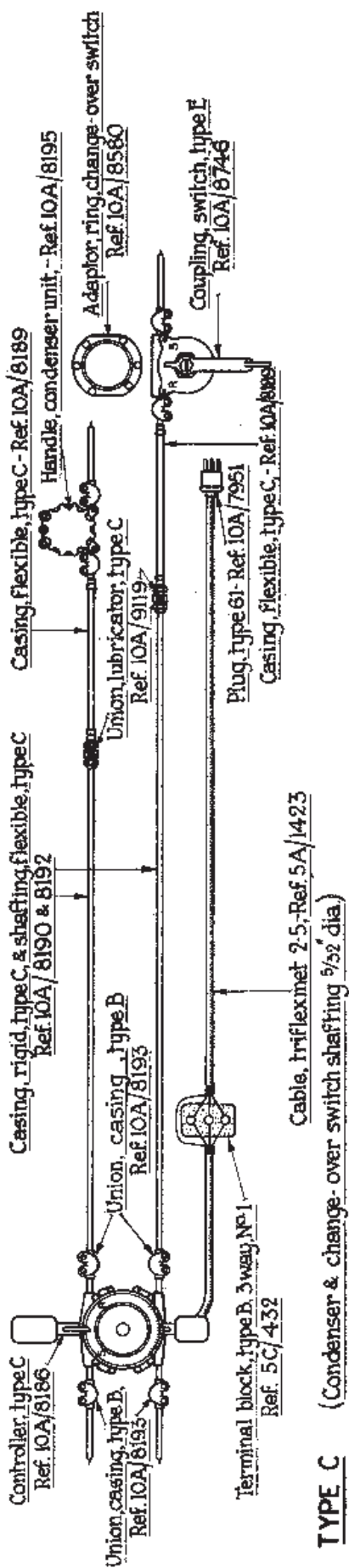


FIG.16. REMOTE CONTROL COMPONENTS

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53. The volume control consists of a high-resistance potentiometer operated by the knob (14). Two different methods of construction are used for the potentiometers in service. One type is built up as an ordinary strip-wound resistance with a contact arm moving over it. The other type consists of a number of resistances connected to contacts on a multiple-contact rotary switch. This type is shown diagrammatically in fig. 15. Forty-four resistances of 1,250 ohms, each with a centre tapping, are mounted round the spindle and connected to the contacts as shown. The ends of this circuit are connected to the H.T. supply with a further resistance of 20,000 ohms in the positive lead, and the contact arm is connected to the screening grids of the valves. The 20,000 ohms resistance connected in series with the potentiometer has the effect of limiting the range of variation of the screen-grid voltage to that required for smooth control of the amplification from a minimum to a maximum.

54. A 2-ft. length of screened three-core cable is supplied with the controller and is connected on installation, to a 3-way terminal block (10). The connections are taken from the terminal block to the three-pin plug (26) for connection to the socket (33) in the side of the receiver. The screening conductors of the two lengths of cable are connected by the bonding wire (9), which is bound to the metal braiding by 30 s.w.g. tinned copper wire soldered in position. In order to test that the bonding is efficient, switch on and tune the transmitter. Rotate the receiver volume control and observe the aerial current. If any change is seen as the volume control is moved, the bonding of the controller probably requires attention. It is important to ensure that the metal sheath of the triflexmet cable is continuous from the controller to the instrument.

55. As the receiver will not function without a potentiometer connected to the socket (33), a type B volume control (34) is provided for use by an observer having access to the transmitter-receiver in a two-seater aeroplane, or for operation of the receiver on the test bench. The type B volume control consists of the potentiometer forming the type A volume control, as used in the controller, fitted into a metal case and having a lead and three-pin plug connected to it. It may be fixed in any convenient position by two screws through a flange; or the wedge plate (35) may be attached to the airframe and the volume control supported on it when easy detachment is required.

56. A key diagram showing the components required for remote control of the T.R.9B and T.R.11B transmitter-receivers is given in fig. 16. The upper sketch shows the type C controls, and the second sketch the type D controls as used with these instruments. In the bottom sketch the type B controls are shown. If these are already installed in the aeroplane they may be used to operate the T.R.9B or T.R.11B. The switch coupling can be attached directly to the plate on the receiver to which the ring adaptor is otherwise fixed. The ring adaptor will not be required, and must be removed. The condenser unit handle requires an adaptor for the type B controls. This adaptor consists of a sleeve, having a spindle carrying two discs, which is adapted to fit into the clamp ring ((32) fig. 14). The inner disc has an eccentric pin to engage in the largest hole in the index plate (28), and the other is arranged to fit the condenser unit handle of the type B controls.

VALVES AND BATTERIES

57. Both oscillator valve and modulator valve in the transmitter are of the same type, *viz.*, V.T.20, having a filament consumption of .2 amp. at 2 volts. The receiver employs two screen-grid valves (V.R. 18) having a filament consumption of .15 amp. at 2 volts, a detector valve V.R.27 and A/F. valves (V.R.21) having a filament consumption of .1 amp. at 2 volts and an output valve (V.R.22) having a filament consumption of .2 amp. at 2 volts.

58. The current for the transmitter and receiver filaments is supplied from a 2-volt accumulator (Stores Ref. 5A/1387). The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery (Stores Ref. 5A/1333) housed in the case of the transmitter-receiver.

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59. A maximum load of 15-18 milliamps. is imposed upon the H.T. battery when the transmitter is in use. The battery should be tested frequently and, if the reading on load is less than 100 volts, the battery should be replaced. A 15-volt grid bias battery is employed to bias the modulator valve of the transmitter and a $4\frac{1}{2}$ -volt grid bias battery is employed to bias the A/F. valves and output valve of the receiver. The 15-volt battery is housed with the H.T. battery in the special tray in the transmitter-receiver case, but the $4\frac{1}{2}$ -volt battery is accommodated in the receiver itself.

TUNING

Transmitter

60. The frequency of the transmitter is adjusted with the use of a wavemeter. The wavemeter W.69 is used for the T.R.9B and the W.75 for the T.R.11B. The method of making the adjustment is as follows :—

61. Erect the wavemeter on the tripod and place it about 6 ft. from the aerial in such a position that the micro-ammeter is clearly visible from the cockpit. Switch on the wavemeter and adjust it to the frequency to which the transmitter is to be set.

62. Before switching on the transmitter set the aerial coil and the grid variometer to give approximately the required frequency. The tables below give representative settings for apparatus installed in small aeroplanes and these may be used as a guide.

63. Turn the switch to SEND and observe the readings on the aerial ammeter and the H.T. milliammeter. The aerial current should be about 0.25 amps. and the input current 15-17 milliamps.

64. Adjust the grid variometer and aerial coil until a maximum reading is obtained on the wavemeter micro-ammeter. The adjustments should be alternated until no further adjustment is necessary. The grid variometer should be adjusted so as to obtain the minimum input, as shown on the H.T. milliammeter and not for maximum output as shown on the aerial ammeter. This procedure is essential in order to avoid instability.

65. The coupling between the transmitter and the wavemeter should be such that the maximum reading obtained on the wavemeter micro-ammeter is about three-quarters of the full scale reading. It may be necessary to move the wavemeter towards or away from the aerial to satisfy this condition.

66. Typical settings for the T.R.9B transmitter unit installed in a small aeroplane with an aerial from wing tip to tail are given below :—

<i>Frequency</i> <i>kc/s.</i>				<i>Aerial coil</i> <i>turns.</i>			<i>Grid variometer</i> <i>degrees.</i>	
4,286	..	..	..	14.0	..	..	..	115
4,700	..	..	..	12.0	..	..	..	90
5,120	..	..	..	10.0	..	..	..	70
5,710	..	..	..	8.0	..	..	..	35
6,010	..	..	..	7.0	..	..	..	30

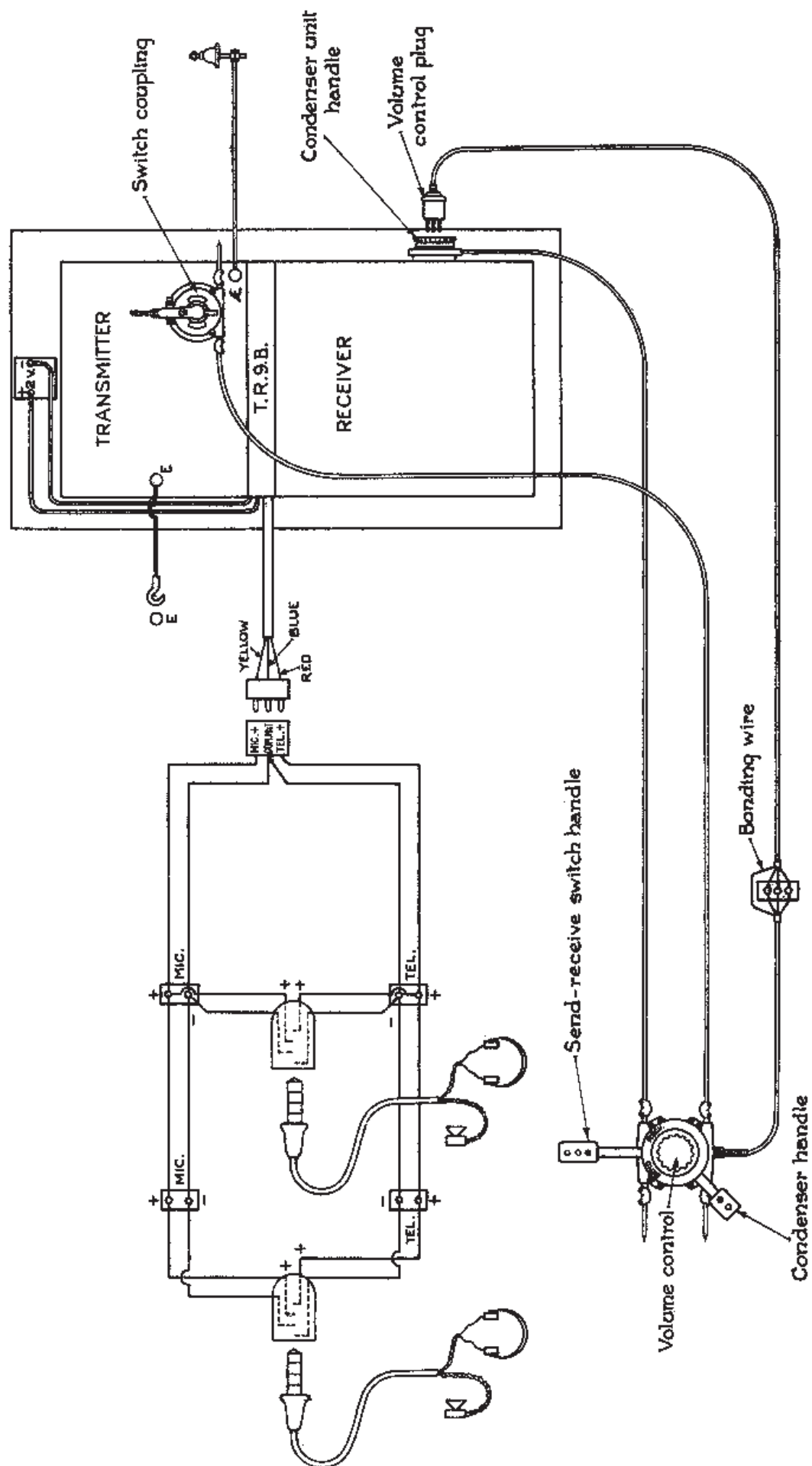


FIG.17. INSTALLATION DIAGRAM OF T.R.9.B.

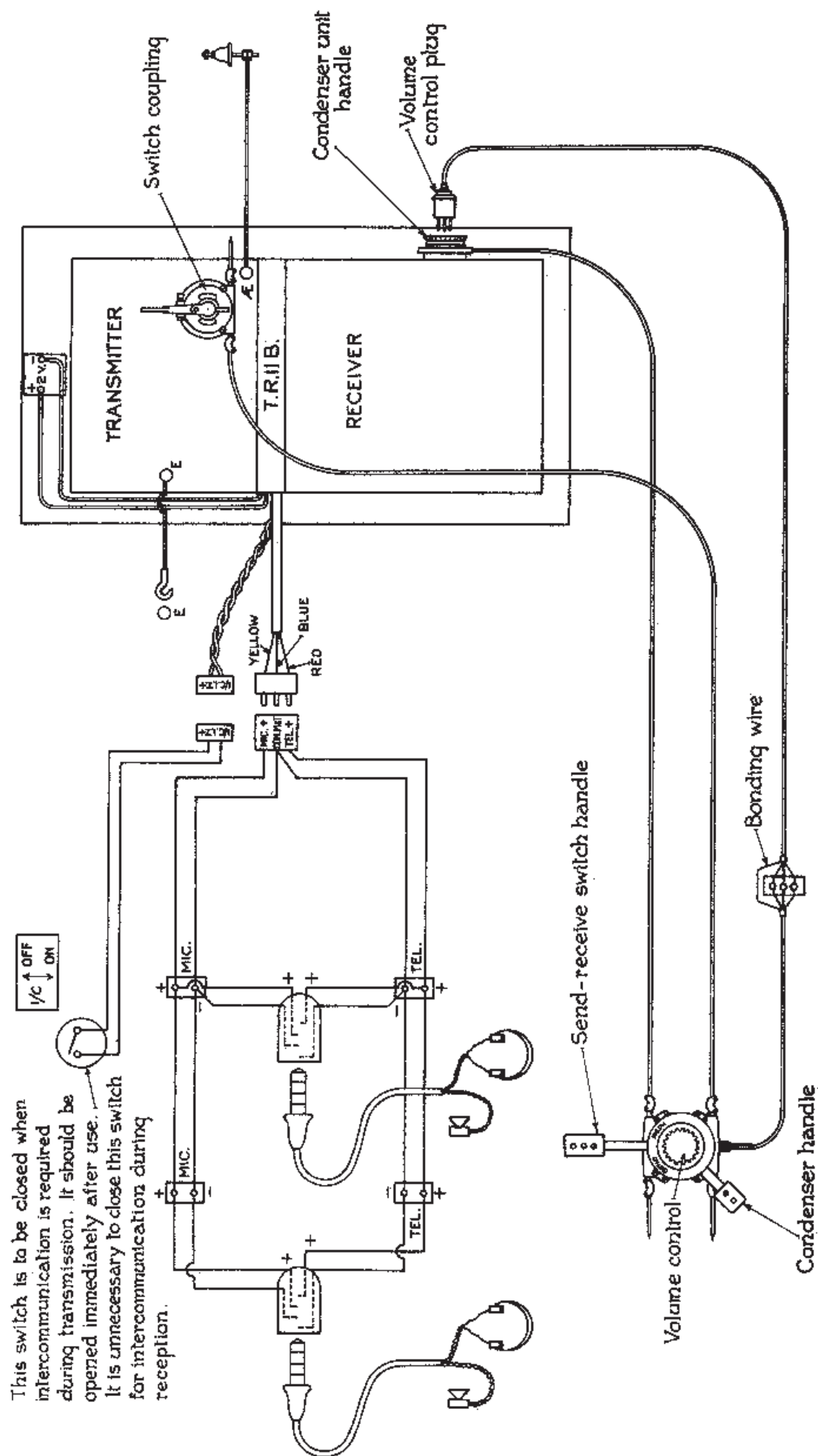


FIG.18. INSTALLATION DIAGRAM OF T.R.IIB.

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67. Typical settings for the T.R.11B transmitter unit installed in a small aeroplane with an aerial from wing tip to tail are given below :—

<i>Frequency</i> <i>kc/s.</i>			<i>Aerial coil</i> <i>turns. degrees.</i>		<i>Grid variometer</i> <i>degrees.</i>		
4,388	..	..	1	180	..	..	60
4,234	..	..	2	20	..	..	84
4,074	..	..	3	20	..	..	84
3,898	..	..	4	20	..	..	100
3,744	..	..	5	20	..	..	106
3,634	..	..	6	20	..	..	106
3,525	..	..	7	20	..	..	118
3,422	..	..	8	20	..	..	120
3,333	..	..	9	20	..	..	150
3,242	..	..	10	20	..	..	160
3,178	..	..	11	20	..	..	160
3,110	..	..	12	20	..	..	160
3,046	..	..	13	20	..	..	180
2,990	..	..	14	20	..	..	180

Receiver

68. The receiver may be tuned by two different methods. The first method is to adjust a transmitter of a similar instrument to the required frequency and to tune the receiver directly from this. The second method is to adjust the transmitter of the same or any similar instrument to the required frequency, tune an R/T tester or wavemeter W.39 or W.39A from this, and then tune the receiver from the R/T tester or either wavemeter. The two methods are described in full below.

69. To tune the receiver directly from a transmitter, the transmitter of another instrument of the same type must first be tuned to the frequency required, by the method described above for transmitters. For this purpose it should be set up with a condenser of about 100 micro-microfarads connected between the aerial and earth terminals instead of connecting the aerial. A microphone must be connected up to the transmitter, and with the switch turned to SEND a constant modulation must be applied. For satisfactory tuning the signal strength received should be adjusted to about strength 5 by moving the transmitter or decreasing its radiation. The receiver is then tuned as follows :—

70. Operate the switch of the transmitter-receiver to RECEIVE, turn the volume control to its highest position and set the regeneration control so that the receiver does not oscillate. Set the tuning control to about 105 degrees, that is, to about the middle of its frequency range. Adjust the main tuning condensers (2), (3) and (4) (fig. 8) to obtain the maximum signal strength in the telephones connected to the receiver.

71. Turn the regeneration control counter-clockwise until the receiver begins to oscillate, and then turn it back until oscillation just stops. A further adjustment of the main tuning condensers will now be required to obtain maximum strength. The tuning and regeneration should be adjusted alternately until a condition is reached when no further improvement is obtained.

72. Turn the volume control and observe the variation in signal strength. The strength should increase uniformly over the entire range of the control and the receiver should be stable at all positions. Turn the tuning control throughout its range and ensure that the receiver is stable in all positions.

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73. Alternatively, the receiver may be tuned by means of the R/T tester, type 1, or the wavemeter W.39. If the tester is used only unit A will be required. The method is as follows :—

74. Set the transmitter of the transmitter-receiver to the frequency required as described under the sub-heading TRANSMITTER. Place the wavemeter, or the unit A of the tester, close to the transmitter, connect a pair of telephones to it and switch to C.W. Switch the transmitter-receiver to SEND and tune the wavemeter or tester to obtain a zero beat frequency.

75. Without disturbing the setting, switch to T.T. and switch the transmitter-receiver to RECEIVE. Tune the receiver as described in the previous paragraph.

76. These methods have the advantage that all frequencies are set from one wavemeter and their accuracy will therefore depend only on the care taken in the operations. The calibration of the R/T tester should not be used and the calibration of the wavemeter W.39 should only be used if no other standard is available.

OPERATION

77. When the aeroplane is on the ground the switch handle of the controller should be locked in the "off" position as a safeguard against wastage of batteries. Immediately before leaving the ground the handle should be moved to the "receive" position and should be maintained in this position, except when transmission is in progress, so that the apparatus is ready to receive a call.

78. Immediately before each flight a test of transmission and of reception should be made, using a fixed aerial. During flight the switch control, the volume control and the tuning are operated as required. Inter-communication is always available during reception. [If it is required during transmission on a T.R.11B the switch installed in the bomb-aiming position must be switched on. This brings the last two valves of the receiver into operation and the pilot is thus able to hear the bomb-aimer's speech while he is transmitting. The switch must be turned off immediately after use.

PRECAUTIONS AND MAINTENANCE

Transmitter-Receiver

79. The two-volt accumulator must be removed and charged at frequent intervals and should always be freshly charged before each flight in which the wireless apparatus is to be used. The high tension battery should be periodically tested for voltage. This may be done by withdrawing the battery tray or by removing the cover between the transmitter and the receiver and connecting the voltmeter between the H.T.+ and the H.T.— contacts. If the voltage on load falls below 100 the battery must be renewed. The plugs should be secure in the battery sockets, and care must be taken not to dislodge them in replacing the battery tray. Should any difficulty be experienced in withdrawing the tray, see that the plugs which fit into the batteries are not too high. The plugs in question are types 91, 93, and 94, and should the contact pin be greater than the depth of the socket, the plug should be cut down so that when inserted in the socket, the shoulder of the plug will bear against the shoulder of the socket.

80. A number of instruments have faulty contact bars, so that the H.T. and grid bias batteries are short-circuited as soon as the transmitter unit is put into the case. In order to rectify the defect arising out of the contacts engraved H.T.+ and G.B.— being flush with the left-hand edge of the bar on its lower side, both the contact bar and the contact should be filed, so that the latter does not come within a sixteenth of an inch of the left-hand side of the contact bar.

81. The input current to the transmitter must be checked periodically. With the modulator valve removed the input should be 7 or 8 milliamps. With the oscillator valve removed the input should also be about 7 or 8 milliamps and the tapping of the grid bias battery should be

adjusted if necessary to give this value. The voltage of the grid bias battery should also be checked and the battery replaced if necessary. The modulator valve is normally biased at 7.5 volts, but if the H.T. battery is fresh, it may be necessary to increase the bias to 9 volts. If the H.T. battery voltage is low it is sometimes desirable to drop the bias to 6 volts. The grid bias battery for the receiver is fitted under the receiver panel. Its voltage must be checked periodically and the security of the plugs examined. If this battery is faulty distorted speech as well as an unduly heavy drain on the H.T. battery will result.

82. The H.T. milliammeter is connected between the H.T. battery and the send-receive switch, and is therefore always in circuit. To avoid any possibility of overloading the milliammeter or the H.T. battery, the H.T. circuit should always be broken by withdrawing the battery tray before beginning any repairs or carrying out such operations as renewing valves.

83. In self-excited transmitters such as those in the T.R.9B and T.R.11B the capacitance of the aerial system affects the frequency of the transmission. It is therefore essential that the leads to aerial and earth, and the aerial itself, should be kept as rigid as possible. If frequency variation is experienced these leads should be carefully examined. The earth terminal should make good electrical contact with the airframe, and to this end there should be no paint on the surfaces making contact. The aerial and earth leads should be strapped down to some rigid member, bearing in mind that the aerial lead must not be close to an earthed conductor. The aerial itself must be correctly tensioned, and when a new aerial is fitted the wire should be stretched before it is fixed.

84. An auxiliary condenser unit handle is available for local operation of the fine-tuning condensers either on the bench or in the aeroplane. It consists of a handle with a disc at the end carrying three pins and having two pins in the side of the handle. The three pins at the end fit into the three holes in the index wheel attached to the end of the condenser spindle, and are used to control the condensers when the remote controls have been taken off. The two pins at the side fit into holes in the condenser unit handle forming part of the remote controls, and these are used when the remote controls are fitted. One of these pins is movable and is spring-loaded, so that the auxiliary handle will remain in place when the pins are inserted into the condenser unit handle.

85. Care should be taken to ensure that the two valves (8 and 9, fig. 8) do not touch the metalwork of the chassis. As the valves are of the metallized type, the bias resistance in the negative filament leads (R_4 and R_5 , fig. 3) will be short-circuited, if the sides of the valves touch the frame-work.

Remote controls

86. When the remote controls are to be disconnected for removal of the transmitter-receiver from the aeroplane, the switch coupling is removed by loosening the clamp screw and pulling the coupling off the adaptor ring attached to the panel, and the condenser unit handle is removed in a similar manner. The positions at which each of these has been fitted should be noted before they are removed. The volume control plug must also be taken out.

87. When the transmitter-receiver is replaced the switch coupling and condenser unit handle should be fitted in the same position as before unless there is any particular reason for changing them. The correct position for the switch coupling may be determined, if it is not known, by putting both the switch and the handle of the coupling in the "off" position and engaging the dog with the switch cross bar. The key should then fit into the appropriate keyway. Particular attention should be paid to ensure that the switch and coupling are in the same position. Failure to do this may result in the send-receive switch overrunning its stops and damaging the switch type, 102. A switch, type 137, and new stop plate are introduced in later transmitters to minimize the possibility of this failure. The condenser unit handle is not keyed and the correct position must be found by trial.

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88. If the shafting has been disengaged from the wheels, or if the position of the switch coupling or condenser unit handle changed, the shafting must be readjusted. When the switch coupling has been fitted in the new position and fixed by tightening the clamp screw, the most convenient position for the handle is then decided on, and the "off" position noted. The stop plate is moved if necessary to correspond with the range of movement decided on for the handle and the handle then fitted. The condenser unit handle is fixed as required and clamped up.

89. The flexible shafting must then be readjusted. The following method is observed in the initial fitting and should be repeated if the shafting has been disturbed. It is assumed that the casing and components are completely assembled.

90. Disconnect the short closed lengths of tubing from the controller and coupling by disengaging the casing unions from the guide tubes. Remove one of the screws fixing each guide tube, slacken the others and swing the tube away from the wheel. Thread the required length of shafting into the casing and push it through until the end is just flush with the free end of the guide tube on the coupling. Turn the handle on the coupling to the position that it would occupy if the shafting were engaged with the wheel and then pulled from the far end. Push the guide tube back into place, meshing the shafting and wheel to the nearest tooth, and screw up the guide tube.

91. Pull the end of the shafting projecting from the controller so as to take up all slack. Turn the handle of the controller to the position it would occupy to pull the shafting as far as possible from the other end and re-fix the guide tube, meshing the shafting and wheel to the nearest tooth. It should now be possible to operate the coupling to either extreme position by movement of the controller handle. When the shafting is pushed away from the controller to its extreme position, the end should be flush with the free end of the guide tube.

92. If there is an intermediate switch coupling for operation of the send-receive switch by the observer, the switch handle of the controller should be placed in the "off" position and locked. The handle of the intermediate coupling should then be turned to the central position and the guide tube pushed into place and screwed up. With the controller handle unlocked it should then be possible to operate the switch to either extreme position by movement of the intermediate handle. Replace the short closed lengths of rigid casing on the free ends of the guide tubes.

93. If in the repair or modification of remote controls it is required to bend the rigid casing, the bending tool supplied for the purpose must be used. The bending tool is of wood and is in the shape of a segment of a circle, with a U-section slot round the edge in which the casing is to be fitted for bending. For the type C rigid casing the tool, bending, type C (Stores Ref. 10A/9006) is used, and for the type D rigid casing the tool, bending, type D (Stores Ref. 10A/9007) is used. In addition, the following precautions must be observed.

94. The cross-section of the casing must not be distorted from the circular form. The appropriate flexible shafting must therefore always be threaded through the casing before the casing is bent. The straight casing adjacent to a bend must be tangential to the bend. The bending tool is to be placed against the casing where the bend is required and the casing bent by hand to the shape of the tool. The bending must be done slowly and without jerks.

TRANSMITTER RECEIVER T.R.9C

(Stores Ref. 10A/10370)

95. Certain modifications have been introduced into the T.R.9B in Fighter Command Units whereby the instrument becomes T.R.9C. Briefly the modifications consist in the introduction of a crystal to stabilize the frequency of the carrier wave. The transmitter unit (T.1102) of the T.R.9B, when modified, will become T.1121 (Stores Ref. 10A/10371). The receiver unit of T.R.9B, *i.e.*, R.1103 (Stores Ref. 10A/9510) will remain unaltered. A modified transmitter unit is illustrated in fig. 19.

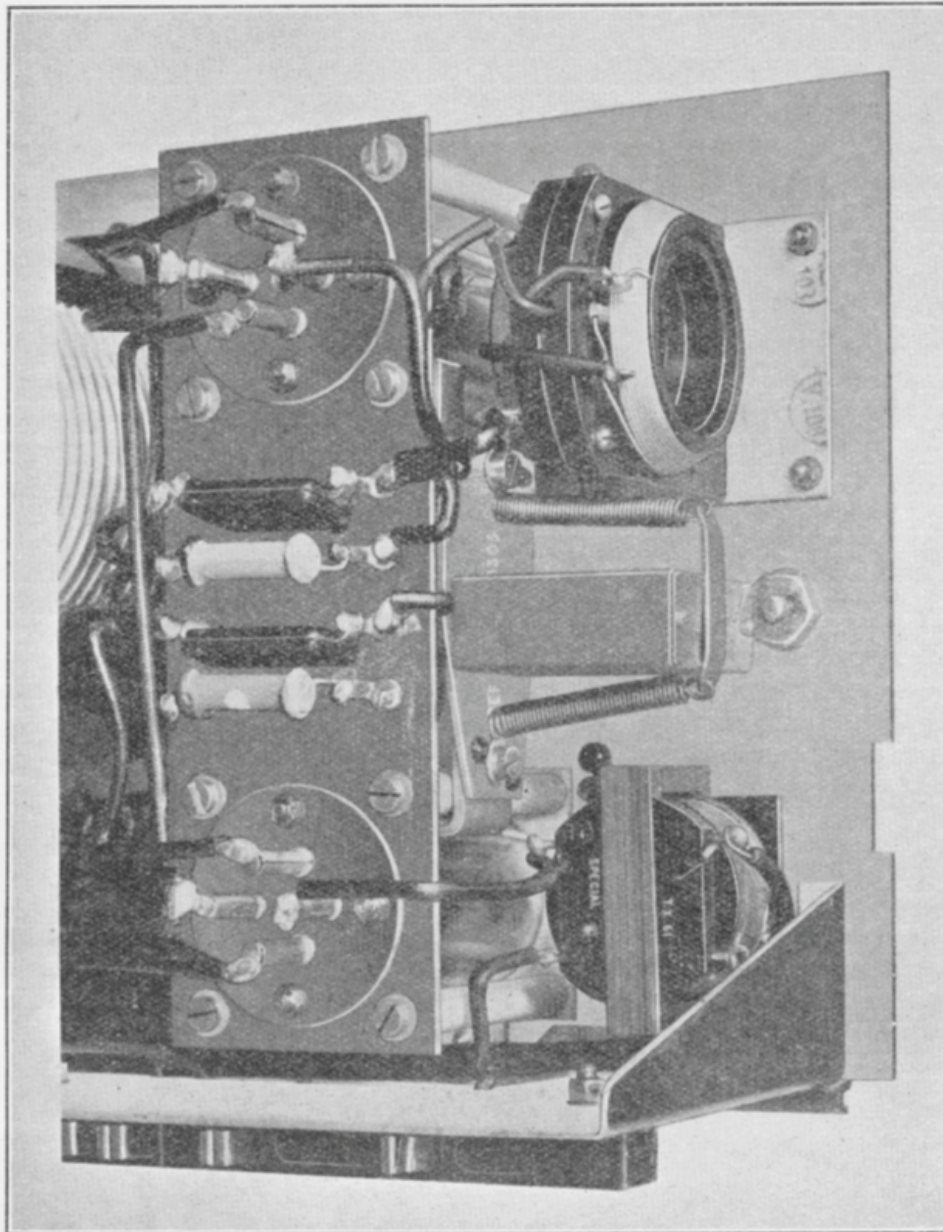


FIG. 19. Transmitter unit of T.R.9C.

OPERATION

Transmitter

96. Turn the aerial tuning control to the zero position and switch on the transmitter. Increase the aerial tuning inductance (noting that the input milliamperes are at a maximum) until a position is reached where the input milliamperes are a minimum. The aerial current indicated in the meter will then be a maximum and should be about 0.2 to 0.25 amp. This point is just prior to the non-oscillating point which can be observed by adjusting slowly once or twice and noting that the input rises suddenly and aerial current falls to zero.

97. Having tuned to maximum aerial current (minimum input reading) reduce the aerial inductance approximately 90° . Switch on the microphone and give a loud hoot, speech or whistle, and note that the aerial current increases. If the reduction of 90° on the dial is

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insufficient for best aerial current increase, a suitable position near-by can be found by trial and error giving a loud hoot, speech or whistle after each adjustment. If the frequency is towards the lower frequency end of the band, the reduction may be as much as 140°.

98. Should the aerial ammeter fail to rise whilst modulating, check the microphone circuit including the modulator valve. See that the transmitter is in a stable oscillating condition. The aerial ammeter should give steady readings as mentioned in para. 96, when the transmitter is switched off and then on again.

Receiver

99. Turn the volume control in the pilot's cockpit to maximum volume position. Except where it is otherwise stated the volume control must remain in the maximum position during the complete tuning operation. Put the fine tuning control to 90°, i.e. to about the middle of its frequency range. Place a R/T tester, modified for use with a crystal, near the tail plane and switch it on. Switch on the receiver and adjust the three main variable condensers until the modulated signal is heard at maximum strength.

100. To obtain the correct tuning, the weakest possible signal *must* be used and this is to be obtained, not by reducing the volume control, but by closing the lid of the case containing the signal generator and if necessary increasing the distance between the generator and the aeroplane. If during the process of tuning, the signal becomes strong, the distance should be still further increased. Having obtained a weak signal at maximum strength, turn the re-generation control in the direction of the arrow until a position is reached where the receiver begins to oscillate. Note the position and turn back one complete turn. Re-tune the three main tuning condensers for maximum signal. Repeat these adjustments until no further increase in signal strength is obtained.

101. Turn the volume control and note that the strength of signal decreases or increases over the entire range of the control and that the receiver remains stable. With the volume control at maximum, move the fine tuning control throughout its range and note where the receiver is stable. Leave the fine tuning control on the 90° position. Should oscillation occur when carrying out these instructions repeat the whole tuning operation, turning the re-generation control back half a turn more, i.e. $1\frac{1}{2}$ turns.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. In ordering spares for this transmitter-receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9507	Transmitter-Receiver T.R.9B, consisting of:—		
10A/9512	Case	1	Fitted with contact bar and plug, type 48.
10A/9214	Bar, contact	1	
10A/9172	Cover, contact bar	1	
10A/9511	Transmitter T.1102	1	
10A/9510	Receiver R.1103	1	
10A/9175	Tray, battery	1	Fitted with 3 contacts and 4 plugs, type 76.
10A/9128	Transmitter-Receiver T.R.11B, consisting of:—		
10A/9213	Case	1	Fitted with contact bar and plugs, types 48 and 62.
10A/9214	Bar, contact	1	
10A/9172	Cover, contact bar	1	
10A/9216	Transmitter T.1098	1	
10A/9215	Receiver R.1099	1	
10A/9175	Tray, battery	1	Fitted with 3 contacts and 4 plugs, type 76.
<i>Transmitters T.1102 and T.1098.</i>			
<i>Principal components.</i>			
10A/7818	Ammeter, thermo, 0 to 0.5	1	
10A/9220	Bar, contact	1	Fitted with 12 contacts.
10A/9227	Base, terminal, 1-way	1	Engraved 29.
10A/9206	Choke, R/F., type 34	1	
10A/7912	Choke, A/F., type G	1	
10A/9207	Coil, aerial	1	For T.1102 only.
10A/9222	Coil, aerial	1	For T.1098 only.
10A/9179	Condenser, type 280	1	.001 μ F.
10A/9185	Condenser, type 286	1	.01 μ F.
10A/9208	Condenser, type 289	1	.002 μ F.
10A/8383	Condenser, type 173	1	.0003 μ F.
10A/9194	Holder, valve, type R	2	
10A/9195	Plate, guard	2	For valve-holders.
10A/7820	Milliammeter, 0 30, type B	1	
10A/7153	Plug, type 29	1	For aerial lead. May not be used when aerial terminal is fitted.
10A/8018	Resistance, type 110	1	0.25 M Ω .
10A/8020	Resistance, type 112	1	30,000 Ω .
10A/9210	Switch, type 102	1	Multi-contact, rotary.
10A/7916	Transformer, microphone, type G	1	
10A/9212	Variometer, grid	1	For T.1102 only.
10A/9221	Variometer, grid	1	For T.1098 only.
<i>Receivers R.1103 and R.1099.</i>			
<i>Principal components.</i>			
10A/9219	Bar, contact	1	Fitted with 7 contacts.
10A/9190	Base, terminal, 1-way	1	Engraved 16.
10A/9191	Base, terminal, 2-way	1	Engraved 14 and 15.
10A/9192	Base, terminal, 3-way	1	Engraved 1, 2 and 3.
10A/9224	Base, terminal, 3-way	1	Engraved 22, 23 and 24.
10A/9193	Base, terminal, 5-way	1	Engraved 4, 5, 6, 7 and 8.

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Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9225	Base, terminal, 5-way	1	Engraved 9, 10, 11, 12 and 13.
10A/9226	Base, terminal, 5-way	1	Engraved 17, 18, 19, 20 and 21.
10A/9189	Can, coil	3	
10A/7384	Choke, A/F., type B	3	
10A/9187	Coil, aerial	3	For R.1103 only.
10A/9217	Coil, aerial	1	For R.1099 only.
10A/9188	Coil, anode	2	For R.1103 only.
10A/9218	Coil, anode	2	For R.1099 only.
10A/7902	Condenser, type 121	1	.001 μ F.
10A/7906	Condenser, type 125	2	.01 μ F.
10A/9178	Condenser, type 279	1	.0003 μ F.
10A/9179	Condenser, type 280	4	.001 μ F.
10A/9180	Condenser, type 281	1	2.0 μ F.
10A/9181	Condenser, type 282	6	0.5 μ F., metal case.
10A/9182	Condenser, type 283	1	Miniature variable.
10A/9183	Condenser, type 284	1	.00005 μ F.
10A/9184	Condenser, type 285	1	.00003 μ F.
10A/9185	Condenser, type 286	1	.01 μ F.
10A/9197	Condenser, type 287	1	Gang of three .000048 μ F. variable air condensers.
10A/9198	Condenser, type 288	3	.000233 μ F. variable air condensers.
10A/9194	Holder, valve, type R	6	
10A/9195	Plate, guard	6	For valve-holders.
10A/9196	Plate, guide	6	For valve-holders.
10A/9202	Knob, indicator	3	
10A/9201	Knob, slow motion	3	
10A/9176	Plug, type 76	3	For grid bias battery.
10A/7910	Resistance, type 97	2	1.5 Ω .
10A/7955	Resistance, type 102	1	2,000 Ω .
10A/8016	Resistance, type 108	2	0.5 M Ω .
10A/8017	Resistance, type 109	1	2 M Ω .
10A/8018	Resistance, type 110	1	0.25 M Ω .
10A/8019	Resistance, type 111	1	100,000 Ω .
10A/8021	Resistance, type 113	4	20,000 Ω .
10A/8117	Resistance, type 123	4	1 M Ω .
10A/8519	Resistance, type 145	1	200,000 Ω .
10A/9199	Ring, clamp	1	With screw.
10A/9200	Screw, clamp	1	
10A/7394	Socket, type 17	1	3-pole.
10A/9203	Wheel, index	1	For ganged condenser
<i>Accessories.</i>			
5A/1333	Battery, dry, 120-volt, type A	1	H.T. for transmitter and receiver (home).
5A/1615	Battery, dry, 120-volt, type B	1	H.T. for transmitter and receiver (overseas).
5A/1338	Battery, dry, 15-volt	1	G.B. for transmitter.
5A/1383	Battery, dry, 4½ volt	1	G.B. for receiver, socket connections.
10A/7938	Case, transit	1	For complete transmitter-receiver.
10A/7813	Valve, V.T.20	2	For transmitter.
10A/7607	Valve, V.R.18	2	Screened grid valves.
10A/7738	Valve, V.R.21	2	A/F. amplifiers.
10A/7958	Valve, V.R.22	1	Output valve.
10A/8239	Valve, V.R.27	1	Detector.
5A/1387	Accumulator, lead-acid, 2-volt, 20 Ah, type B	1	All L.T.

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Ref. No.	Nomenclature.	Quantity.	Remarks.
<i>Remote Controls.</i>			
<i>Type C Remote Controls</i>			
10A/8186	Controller, type C, consisting of :—		With 2-ft. lead.
10A/8187	Control, switch and tuning		
10A/8188	Control, volume, type A		50,000 Ω .
5A/1782	Wire, T.C., 30 s.w.g.		For binding bonding wire.
10A/8746	Coupling, switch, type E, which fits on to :—		
10A/8580	Adaptor, ring, change-over switch.		
10A/7951	Plug, type 61, with lead		
10A/8195	Handle, condenser unit		
10A/8274	Handle, condenser unit, auxiliary		For local operation of 10A/8195.
10A/8998	Control, volume, type B		Similar to 10A/8188 fitted in a case.
			For local volume control.
10A/8999	Wedge plate		For mounting 10A/8998.
10A/8190	Casing, rigid, type C		For 10A/8192.
10A/8189	Casing, flexible, type C		For 10A/8192.
10A/8192	Shafting, flexible, type C		$\frac{5}{8}$ in. dia.
10A/8193	Union, casing, type B		For 10A/8190 and 10A/8189.
10A/9515	Pin, key		For 10A/8193.
10A/9119	Union, lubricator, type C		For 10A/8190.
5C/432	Block, terminal, type B, 3-way, No. 1.		
10A/8585	Cleat, type C		For 10A/8190.
10A/9006	Tool, bending, type C		For installation 10A/8190.
5A/1423	Cable, triflexmet, 2.5		
<i>Type D Remote Controls</i>			
10A/8907	Controller, type D, consisting of :—		With 2-ft. lead.
10A/8581	Control, switch and tuning, type D.		
10A/8188	Control, volume, type A		50,000 Ω .
5A/1782	Wire, T.C., 30 s.w.g.		For binding bonding wire.
10A/7951	Plug, type 61, with lead.		
10A/8589	Coupling, switch, type D, which fits on to :—		
10A/8580	Adaptor, ring, change-over switch.		
10A/8195	Handle, condenser unit.		
10A/8274	Handle, condenser unit, auxiliary		For local operation of 10A/8195.
10A/8998	Control, volume, type B		Similar to 10A/8188 fitted in a case.
			For local volume control.
10A/8999	Wedge plate		For mounting 10A/8998.
10A/8190	Casing, rigid, type C		For 10A/8192.
10A/8583	Casing, rigid, type D		For 10A/8593.
10A/8189	Casing, flexible, type C		For 10A/8192.
10A/8582	Casing, flexible, type D		For 10A/8593.
10A/8192	Shafting, flexible, type C		$\frac{5}{8}$ in. dia.
10A/8593	Shafting, flexible, type D		$\frac{5}{8}$ in. dia.
10A/8193	Union, casing, type B		For 10A/8190 and 10A/8189.
10A/9515	Pin, key		For 10A/8193.
10A/8595	Union, casing, type D		For 10A/8583 and 10A/8582.
10A/9516	Pin, key		For 10A/8595.
10A/9119	Union, lubricator, type C		For 10A/8190.
10A/9120	Union, lubricator, type D		For 10A/8583.
5C/432	Block, terminal, type B, 3-way, No. 1.		
10A/8585	Cleat, type C		For 10A/8190.
10A/8586	Cleat, type D		For 10A/8583.
10A/9006	Tool, bending, type C		For installation of 10A/8190.
10A/9007	Tool, bending, type D		For installation of 10A/8583.
5A/1423	Cable, triflexmet, 2.5		
<i>Type B Remote Controls</i>			
10A/7936	Controller, consisting of :—		
10A/7939	Control, switch and condenser.		
10A/7937	Control, volume		

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Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7501	Coupling, switch		
10A/7925	Handle, condenser unit.		
10A/9129	Adaptor, condenser coupling.		
10A/7503	Casing, type B		
10A/7504	Shafting, type B.		
10A/7505	Unions, casing.		
10A/10370	Transmitter-receiver, T.R.9C, comprising :—		
10A/10371	Transmitter T.1121		See below.
10A/9510	Receiver R.1103.		
	Transmitter T.1121, comprising :—		
10A/9511	Transmitter T.1102.		
10A/10305	Holder, crystal, type 1	1	

December, 1938

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Volume I

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TRANSMITTER-RECEIVER T.R.1091

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TRANSMITTER-RECEIVER T.R.1091

(Stores Ref. 10A/9275.)

INTRODUCTION

1. This instrument is a combined transmitter-receiver. The transmitter unit and the receiver unit are mounted on a common base-board. Change-over from transmit to receive is made by means of a send-receive switch mounted on the base-board between the two units. The transmitter is capable of radiating C.W., I.C.W., and R/T, and covers the frequency bands 1,222-1,539 kilocycles and 2,000-3,409 kilocycles. The inductances are permanently mounted both in transmitter and receiver, and change of frequency is effected by means of switches. The transmitter unit which is a master-oscillator controlled transmitter, is known as transmitter T.1092. The receiver unit is known as receiver R.1093. The switch unit mounted between them is known as switch unit Type E. Although the transmitter is capable of radiating C.W., I.C.W. and R/T throughout the whole of the frequency bands, reception of C.W. is provided for on the receiver only over the band 2,000-3,400 kilocycles. The overall dimensions of the T.R.1091 are approximately 24 in. $\times$ 12 in. $\times$ 10 $\frac{3}{4}$ in., and the weight complete with wired switch unit and valves is 43 $\frac{1}{2}$ lb.

GENERAL DESCRIPTION

2. In fig. 1 is shown an illustration of the transmitter-receiver T.R.1091. It will be seen that the transmitter is situated on the right and the receiver on the left with a change-over switch between them, the whole being mounted on a shock-absorbing mounting board. On the right-hand side of the receiver are a number of spring jaw contacts, and on the left-hand side of the transmitter a row of similar contacts are provided. A rotor situated in the switch unit is provided with blades, and rotation of the rotor allows engagement with either transmitter or receiver.

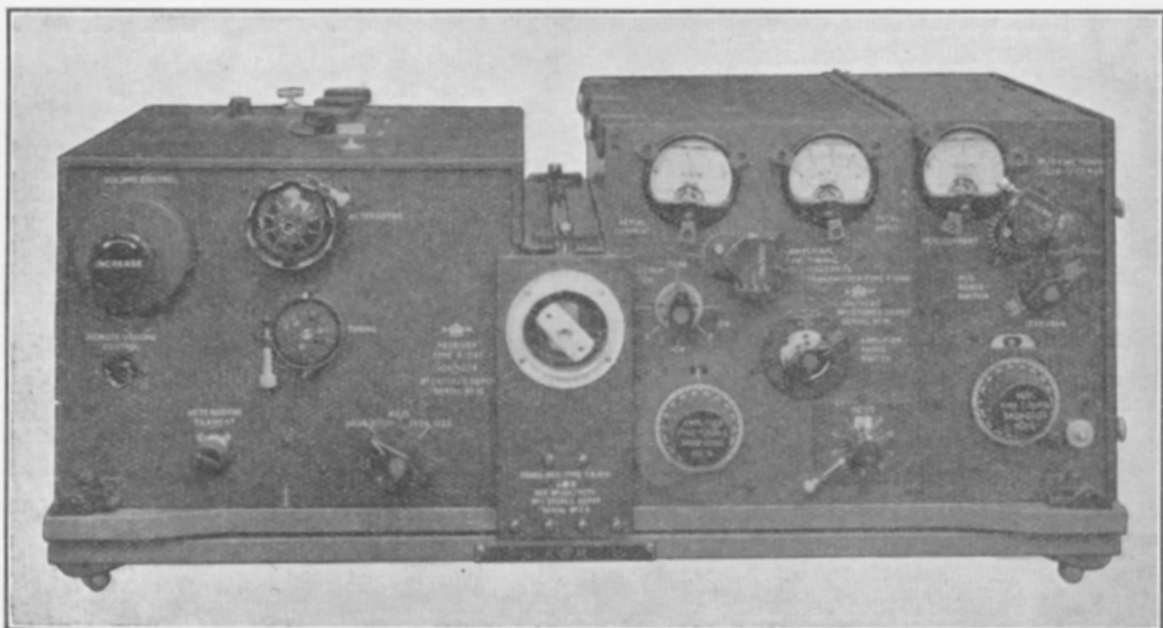


FIG. 1. Transmitter-receiver T.R. 1091, front view.

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Transmitter T.1092

3. Referring to fig. 2 it will be seen that the transmitter comprises a master-oscillator valve V and an amplifier valve V_1 . The inductances L and L_1 are the low and high-frequency inductances respectively for the master-oscillator. The inductance L is tuned on the vario-meter principle. The inductance L_1 is tuned by means of a variable tap. Both of these inductances are fixed in the transmitter but change-over from one to the other is effected by means of the switch S. This switch is a four-pole switch with four positions corresponding to the four frequency bands of the transmitter. It will be seen that in position 1 the inductance L_1 is in use and the inductance L is short-circuited. In position 2 the inductance L is again short-circuited but the switch S_1 is closed and the loading condenser C_3 is connected across part of L_1 . In position 3 the short-circuit is removed from the high-frequency inductance, S_1 is opened and the low-frequency inductance short-circuited. In the fourth position theappings on the high-frequency inductance are altered, the other connections remaining the same as for position 3.

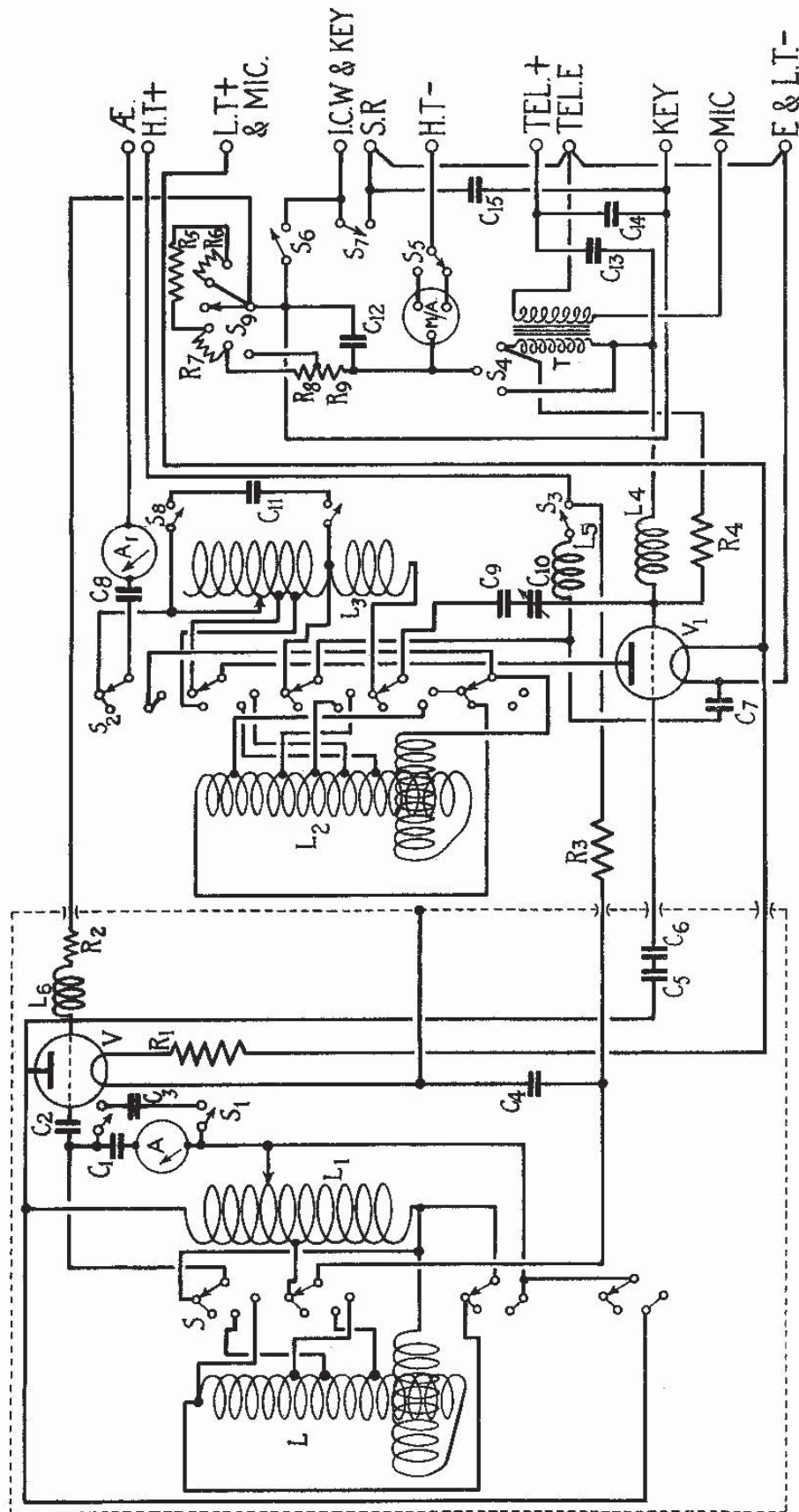
4. A similar switching arrangement is provided in the amplifier circuit, the switches S_2 and S_8 carrying out the changes for the four frequencies. The switch S_2 is a five-pole four-position switch. In position 1 the inductance L_3 is in use and the inductance L_2 is short-circuited. In position 2 the inductance L_2 is again short-circuited but the condenser C_{11} is connected in parallel with L_3 . In position 3 the inductance L_2 is in use and L_3 is open-circuited. In position 4 the high-frequency inductanceappings are altered, L_3 still being left open-circuited. The circuit changes for both the master-oscillator and amplifier for the four positions of the range switches are given in fig. 3.

5. The condensers C_9 and C_{10} are connected in series between the grid of the amplifier and the neutralizing winding on either of the coils L_1 or L_3 . C_9 is a fixed blocking condenser. C_{10} is the adjustable neutralizing condenser. L_4 is the radio-frequency choke in the amplifier grid circuit. L_5 is the radio-frequency choke in the H.T. feed to the amplifier. R_3 is a resistance in the anode feed to the master-oscillator.

6. The M/O valve is coupled to the amplifier by the condenser C_6 , and a further fixed condenser C_5 of small capacitance is introduced for safety purposes. The grid of the M/O is connected through the condenser C_2 to either the high or low-frequency coil depending on the position of the switch S. A filament resistance R_1 is included in the positive filament lead of the M/O valve. A mains condenser C_4 is connected between H.T.+ and earth. The grid of the M/O valve is also connected to the selector arm of the grid bias arrangement through a R/F choke L_6 and a grid leak resistance R_2 .

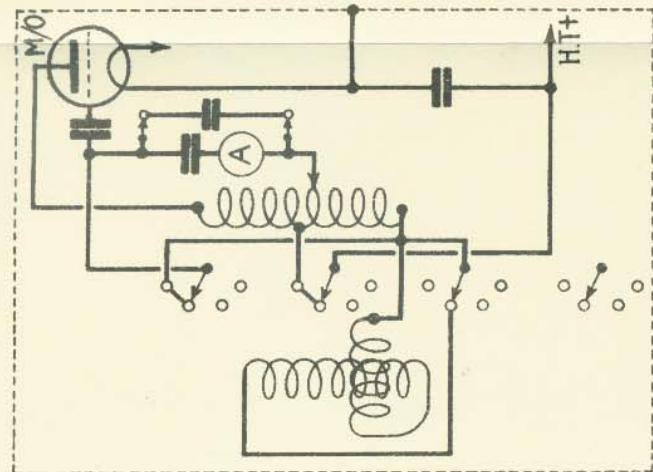
7. In the amplifier valve chamber, C_8 is the aerial blocking condenser and C_7 is the mains condenser, the latter being connected between the positive H.T. feed and the negative side of the filament circuit. A .5 megohm resistance R_4 is shunted across the grid choke and transformer secondary. A condenser C_{15} is shunted across the contacts engraved S.R. and KEY, while C_{12} is an A/F by-pass condenser connected across the bias resistance.

8. A number of switches S_3 , S_4 , S_5 , S_6 and S_7 are shown at various points in the diagram. These are simultaneously operated by the movement of the handle of the selector switch. S_3 breaks the H.T. feed to the amplifier in the "Tune" position. S_6 changes the milliammeter range from 0-40, to 0-120 milliamps. S_7 short-circuits the interrupter when C.W. or R/T is required. S_8 short-circuits the key when R/T is required. S_4 short-circuits the secondary of the microphone transformer on I.C.W. and C.W. and also opens the grid circuit when on "Tune". In addition various values of grid bias resistance are selected by the various positions of the switch S_9 . The grid bias arrangement is in effect a number of resistances R_5 , R_6 , R_7 , R_8 and R_9 in series connected between H.T.— and L.T.—, and a switch arm short-circuits more or less of these according to the bias required. The grid circuit of the amplifier is connected to the H.T.— end, and the I.R. drop, which varies with the amount of resistance short-circuited, applies the necessary negative bias to the grid of the amplifier. The circuit changes effected by the selector switch for its six positions are shown in fig. 4.

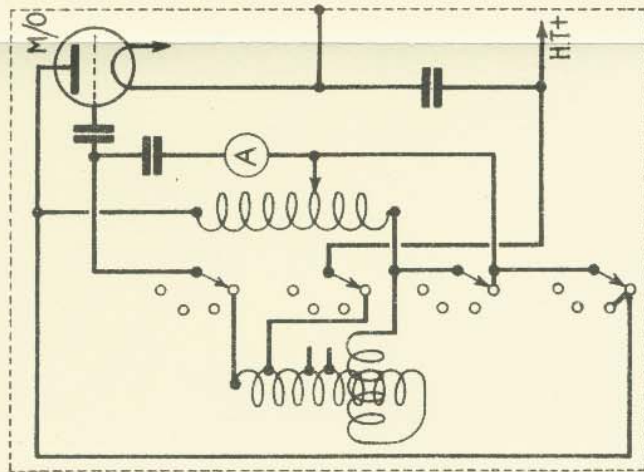


Condensers		
C ₁ = .00018 μ F	C ₉ = .001 μ F	R ₂ = 15,000 Ω
C ₂ = .0005 μ F	C ₁₀ = .00006 μ F - Variable	R ₃ = 10,000 Ω
C ₃ = .000065 μ F	C ₁₁ = .000065 μ F	R ₄ = 500,000 Ω
C ₄ = .002 μ F	C ₁₂ = .5 μ F	R ₅ = 1,800 Ω
C ₅ = .000025 μ F	C ₁₃ = .002 μ F	R ₆ = 800 Ω
C ₆ = .002 μ F	C ₁₄ = .002 μ F	R ₇ = 600 Ω
C ₇ = .0004 μ F	C ₁₅ = .01 μ F	R ₈ = 600 Ω
C ₈ = .01 μ F	Resistances	R ₉ = 1,200 Ω
	R ₁ = 1.3 Ω	

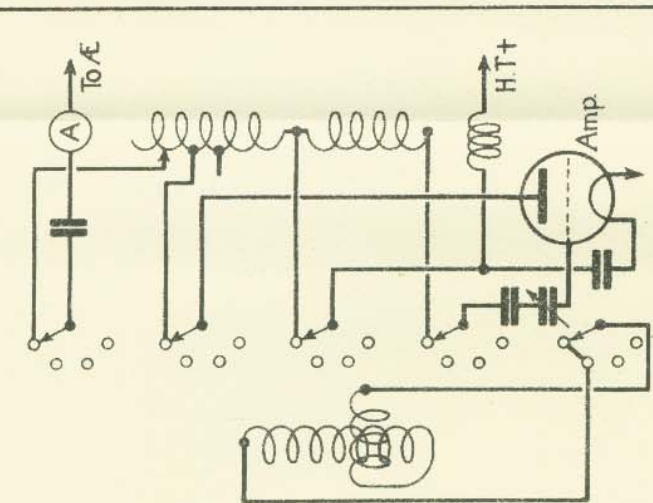
FIG. 2. THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER, T.1092



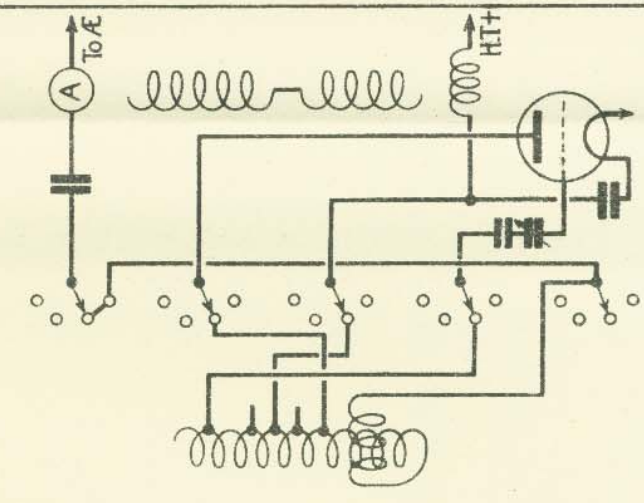
Range 2500 to 2000 kc/s.



Range 1364 to 1222 kc/s.



Range 3409 to 2500 kc/s.



Range 1539 to 1364 kc/s.

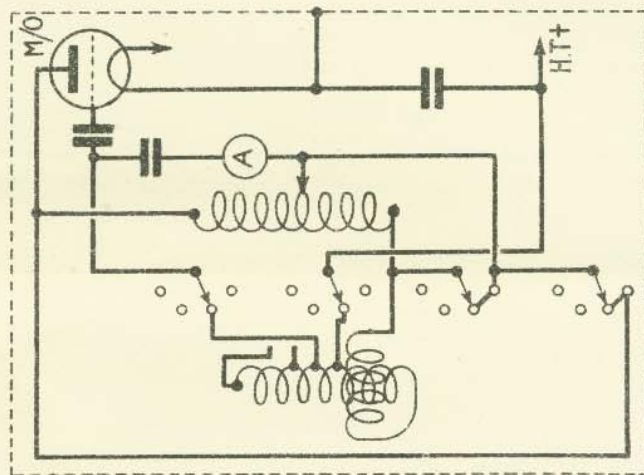
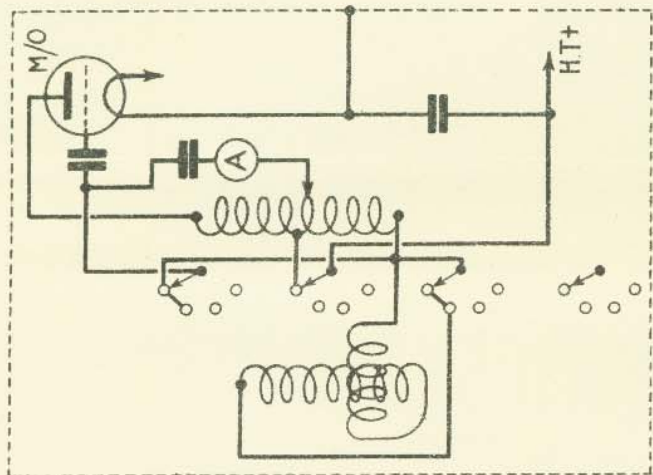


FIG. 3. CIRCUIT CHANGES FOR THE FOUR POSITIONS OF AMP. AND M/O RANGE SWITCHES

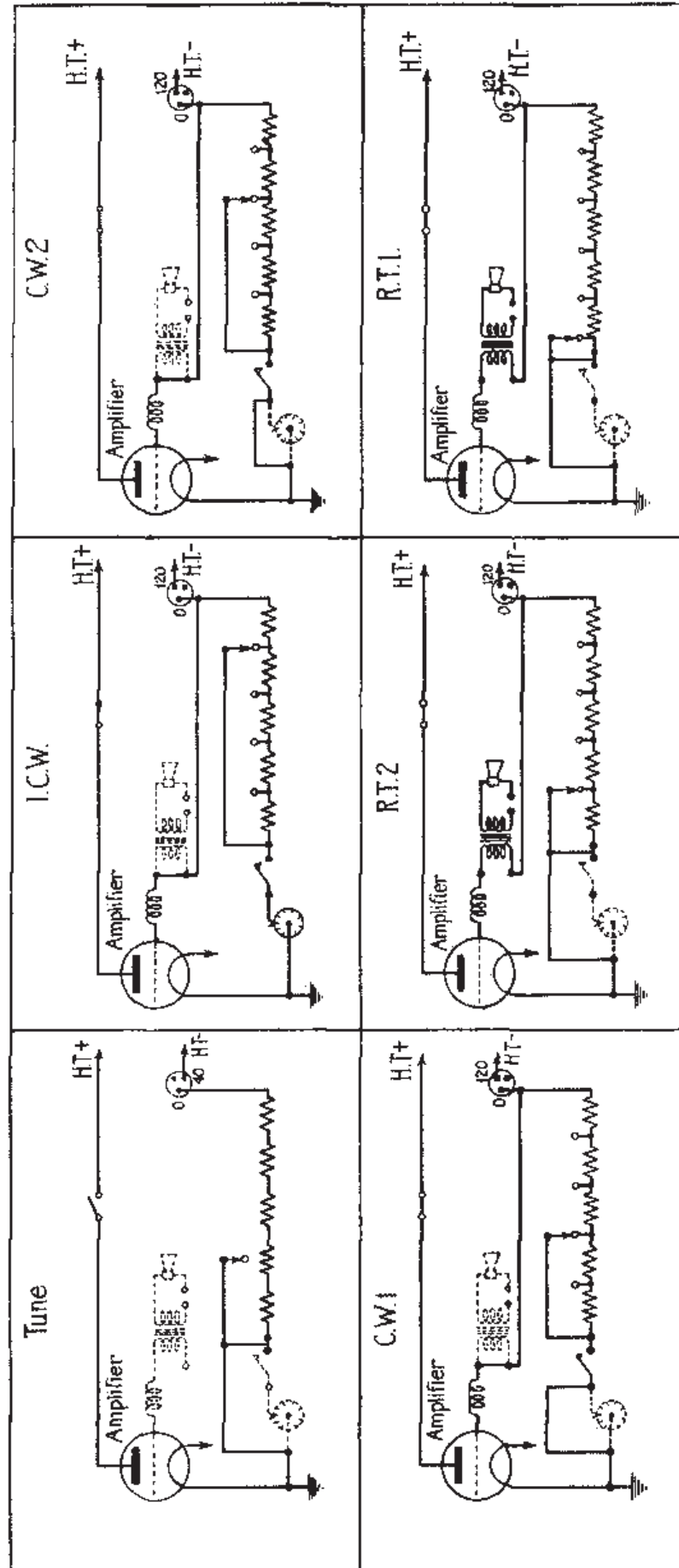
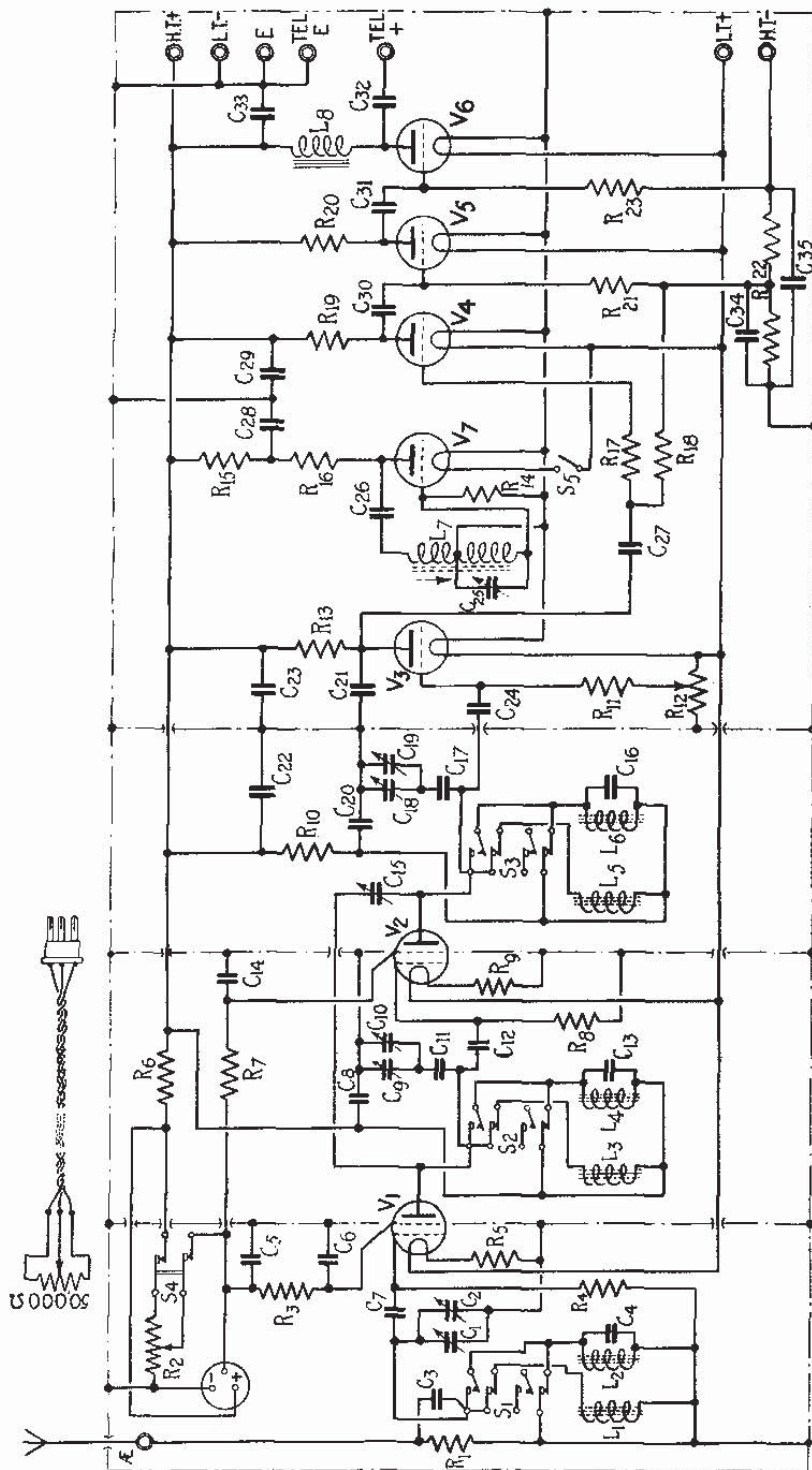


FIG. 4. CIRCUIT CHANGES FOR DIFFERENT POSITIONS OF SELECTOR SWITCH



Condensers	ITEM ON SET	$C_{15} = 10 \mu\text{F} - \text{Variable}$	$C_{30} = .001 \mu\text{F}$	22	$R_9 = 1.5 \Omega$	12
$C_1 = .00005 \mu\text{F} - \text{Variable}$		$C_{16} = .00005 \mu\text{F}$	$C_{11} = .001 \mu\text{F}$	25	$R_{10} = 1,000 \Omega$	18
$C_2 = .00025 \mu\text{F} - \text{Variable}$		$C_{17} = .01 \mu\text{F}$	$C_{32} = .5 \mu\text{F}$		$R_{11} = 250,000 \Omega$	
$C_3 = .00005 \mu\text{F}$	1	$C_{18} = .00005 \mu\text{F} - \text{Variable}$	$C_{33} = 2 \mu\text{F}$		$R_{12} = 135 \Omega - \text{Variable}$	
$C_4 = .00005 \mu\text{F}$	3	$C_{19} = .00025 \mu\text{F} - \text{Variable}$	$C_{34} = .5 \mu\text{F}$		$R_{13} = 100,000 \Omega$	14
$C_5 = .5 \mu\text{F}$		$C_{20} = .5 \mu\text{F}$	$C_{35} = 2 \mu\text{F}$		$R_{14} = 100,000 \Omega$	27
$C_6 = .5 \mu\text{F}$		$C_{21} = .001 \mu\text{F}$	Resistances	ITEM ON SET	$R_{15} = 50,000 \Omega$	29
$C_7 = .0001 \mu\text{F}$	6	$C_{22} = .5 \mu\text{F}$	$R_1 = 500,000 \Omega$	2	$R_{16} = 100,000 \Omega$	30
$C_8 = .5 \mu\text{F}$		$C_{23} = .5 \mu\text{F}$	$R_2 = 50,000 \Omega - \text{Variable}$		$R_{17} = 2 \text{ M}\Omega$	19
$C_9 = .00005 \mu\text{F} - \text{Variable}$		$C_{24} = .0001 \mu\text{F}$	$R_3 = 100,000 \Omega$	4	$R_{18} = 1 \text{ M}\Omega$	13
$C_{10} = .00025 \mu\text{F} - \text{Variable}$		$C_{25} = .0001 \mu\text{F}$	$R_4 = 500,000 \Omega$	5	$R_{19} = 100,000 \Omega$	24
$C_{11} = .01 \mu\text{F}$		$C_{26} = .001 \mu\text{F}$	$R_5 = 1.5 \Omega$	28	$R_{20} = 100,000 \Omega$	21
$C_{12} = .0003 \mu\text{F}$	8	$C_{27} = .001 \mu\text{F}$	$R_6 = 20,000 \Omega$	20	$R_{21} = 1 \text{ M}\Omega$	23
$C_{13} = .00005 \mu\text{F}$	7	$C_{28} = 1 \mu\text{F}$	$R_7 = 50,000 \Omega$	9	$R_{22} = 180 \Omega \text{ Centre-tapped}$	
$C_{14} = .5 \mu\text{F}$		$C_{29} = .5 \mu\text{F}$	$R_8 = 500,000 \Omega$	10	$R_{23} = 1 \text{ M}\Omega$	20

FIG.5. THEORETICAL CIRCUIT DIAGRAM OF RECEIVER. R.1093

PRC.

9. It will be seen that two contacts marked TEL. + and TEL. E are provided. These are for the purpose of providing side-tone. When the send-receive switch is in the "send" position the telephones are connected to these two contacts on the transmitter, and as a result the telephones are connected (on R/T) through the condenser C_{13} to the secondary of the microphone transformer T. On I.C.W. the telephones are connected across the key and interrupter in series with the condenser C_{14} . On C.W. the interrupter is of course short-circuited and only key clicks are heard.

Receiver R.1093

10. A circuit diagram of the receiver is given in fig. 5. It will be seen that it consists of a two-stage radio-frequency amplifier, a detector, a separate heterodyne and a three stage audio-frequency amplifier. The three tuned circuits of the radio-frequency amplifier employ iron-cored inductances, and a range switch simultaneously selects the appropriate inductance in each circuit for the required frequency range. The three circuits are separately tuned by three trimming condensers situated on the top of the receiver. Fine tuning is provided by three ganged variable condensers in parallel with the trimming condensers. These may be remotely controlled. A volume control varies the voltage applied to the screen grids of the R/F valves. The audio-frequency valves are resistance-capacitance coupled, and the output valve incorporates choke output. The separate heterodyne employs a variable permeability coil, the inductance of the coil being varied by moving the core. The frequency of the heterodyne and hence the beat note may be remotely controlled.

11. Referring to fig. 5, L_1 and L_2 are the low and high-frequency inductances respectively, which are switched alternatively into circuit by means of the switch S_1 , the variable condensers C_1 and C_2 being connected in parallel across the particular inductance in circuit. The condenser C_4 is shunted across the high-frequency inductance, while C_3 is the aerial coupling condenser. The control grid of the screen grid valve V_1 is coupled to the aerial inductance by means of the condenser C_7 , and the resistance R_4 is connected between the control grid of the valve and earth. The screening grid is fed through the resistance R_3 and the potential is varied by means of a tapping on the potentiometer resistance R_2 , which is connected across the H.T. supply. In order to provide for remote control of the screen grid potential, a 3-point socket is provided into which a 3-point plug is inserted which in turn is connected to a remote potentiometer with a resistance similar to R_2 . The socket incorporates a switching device S_4 which is operated by an additional pin on the plug. On inserting the plug the switch is operated and the internal potentiometer R_2 is disconnected. The series resistance R_5 is de-coupled by the condenser C_6 , while C_5 is a by-pass condenser connected to the H.T. end of R_3 . The resistance R_1 is connected between aerial and earth as a static leak, and the resistance R_3 is a fixed resistance in the filament negative lead.

12. The valve V_2 is coupled to the anode of the preceding valve by means of a condenser C_{12} , the resistance R_8 being connected between the control grid of V_2 and earth. Two inductances L_3 and L_4 , the latter having a condenser C_{13} shunted across it, are provided for high and low frequencies respectively. A switching device S_2 changes over from one to the other. The variable condensers C_9 and C_{10} perform a similar function to C_1 and C_2 , but in addition a blocking condenser C_{11} is connected between the fixed vanes and the inductance. A further condenser C_8 is connected between the moving vanes of the condensers C_9 and C_{10} and the inductance. The moving vanes are earthed. The screen grid of the valve V_2 is fed through the resistance R_7 and receives its supply from the potentiometer R_2 which supplies the potential to the screen grid of the valve V_1 . Between the anode of the valve V_1 and the anode of the valve V_2 , is connected a small variable condenser C_{15} , which functions as a reaction condenser. The series resistance R_7 is de-coupled by means of the condenser C_{14} . The inductances L_3 and L_4 are connected direct to H.T.+. The valve V_2 is coupled to the detector valve through the condenser C_{24} .

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13. The grid of the detector valve is connected through the grid leak resistance R_{11} to a potentiometer R_{12} , the resistance of which is connected across the L.T. supply. Anode inductances L_5 and L_6 (high and low-frequency inductances respectively) are switched by means of the switch S_3 , and they are connected to H.T. through the resistance R_{10} , the H.T. end of which is connected to earth through the condenser C_{23} . The high frequency inductance L_8 has the condenser C_{16} shunted across it. The moving vanes of the variable condensers C_{18} and C_{19} are connected to earth and the fixed vanes are connected through the condenser C_{17} and the switch S_3 to the appropriate inductance. The connection between the moving vanes and the inductance is made through the condenser C_{20} . No resistance is provided in the detector filament circuit. The anode circuit of the detector is fed from H.T. + through the resistance R_{13} , which is de-coupled by the condenser C_{21} , the by-pass condenser C_{23} being connected between the H.T. side of the resistance R_{13} and earth. The detector is coupled to the valve V_4 by means of the condenser C_{27} , in series with which is the grid stopper resistance R_{17} , the resistance R_{18} being the grid resistance. Bias is applied to the grid of the valve V_4 from a centre tapping on the resistance R_{22} , the latter being connected between H.T. — and earth.

14. Also associated with this valve is the anode resistance R_{19} and the by-pass condenser C_{29} . The grid of the valve V_5 is coupled to the valve V_4 by means of the condenser C_{30} and the grid is connected through the resistance R_{21} to the centre tapping point of R_{22} . A condenser C_{35} is shunted across R_{22} , while another condenser C_{34} is connected between the centre point of the resistance and earth. The H.T. anode supply to the valve V_5 is through the resistance R_{20} . The valve V_5 is in turn coupled to the output valve through the condenser C_{31} . The grid of the output valve V_6 is connected through the resistance R_{23} to H.T. —. Choke output is employed in the anode circuit of the valve V_6 , L_8 being connected in the anode circuit and the telephones being connected in series with the condenser C_{32} between anode and earth. A $2\mu F$ condenser C_{33} is connected between H.T. + and earth.

15. The anode of the heterodyne valve V_7 is connected through the two resistances R_{15} and R_{16} to H.T. +, C_{28} being the de-coupling condenser for R_{15} . A tuned circuit formed by a portion of the inductance L_7 and the pre-set condenser C_{25} is connected in the grid circuit of the heterodyne valve V_7 , and the end turns of this inductance are coupled back through the condenser C_{26} to the anode of the valve to maintain oscillation. The inductance is varied and hence the oscillator frequency, by moving the core by means of a handle on the front of the receiver, which may be remotely controlled if desired. R_{14} is a 100,000 ohm resistance connected between grid and filament, to maintain the grid potential at a suitable mean value. A switch S_5 is provided in the filament circuit of the valve. A handle on the front of the receiver operates this switch and is engraved ON and OFF.

Switch unit, type E

16. In order to make the necessary change-over of connections from reception to transmission and *vice versa*, a switch unit is provided. This switch unit comprises a spindle of insulating material carrying contact blades, the spindle being capable of rotation in a frame of insulating material. Spring jaw contacts are carried on both the receiver and transmitter, and the blades on the rotatable element may be engaged with either the transmitter contacts or the receiver contacts by rotating the spindle. An intermediate or "off" position is provided in which the blades are not engaged with either the transmitter or receiver.

17. The connections from the switch unit to the batteries, aerial and earth, etc. (which are changed over from transmitter to receiver by the operation of the switch), are taken out as flexible leads through an opening in the end of the switch unit. Since the arrangement of the installation differs for various types of aeroplane, the switch unit wiring is arranged to suit. In fig. 6 is given an illustration of the switch unit, and also a diagram of the actual connections made for a Hector aeroplane installation. In fig. 7 is given a simplified diagram showing the changes effected in the circuit by the switch.

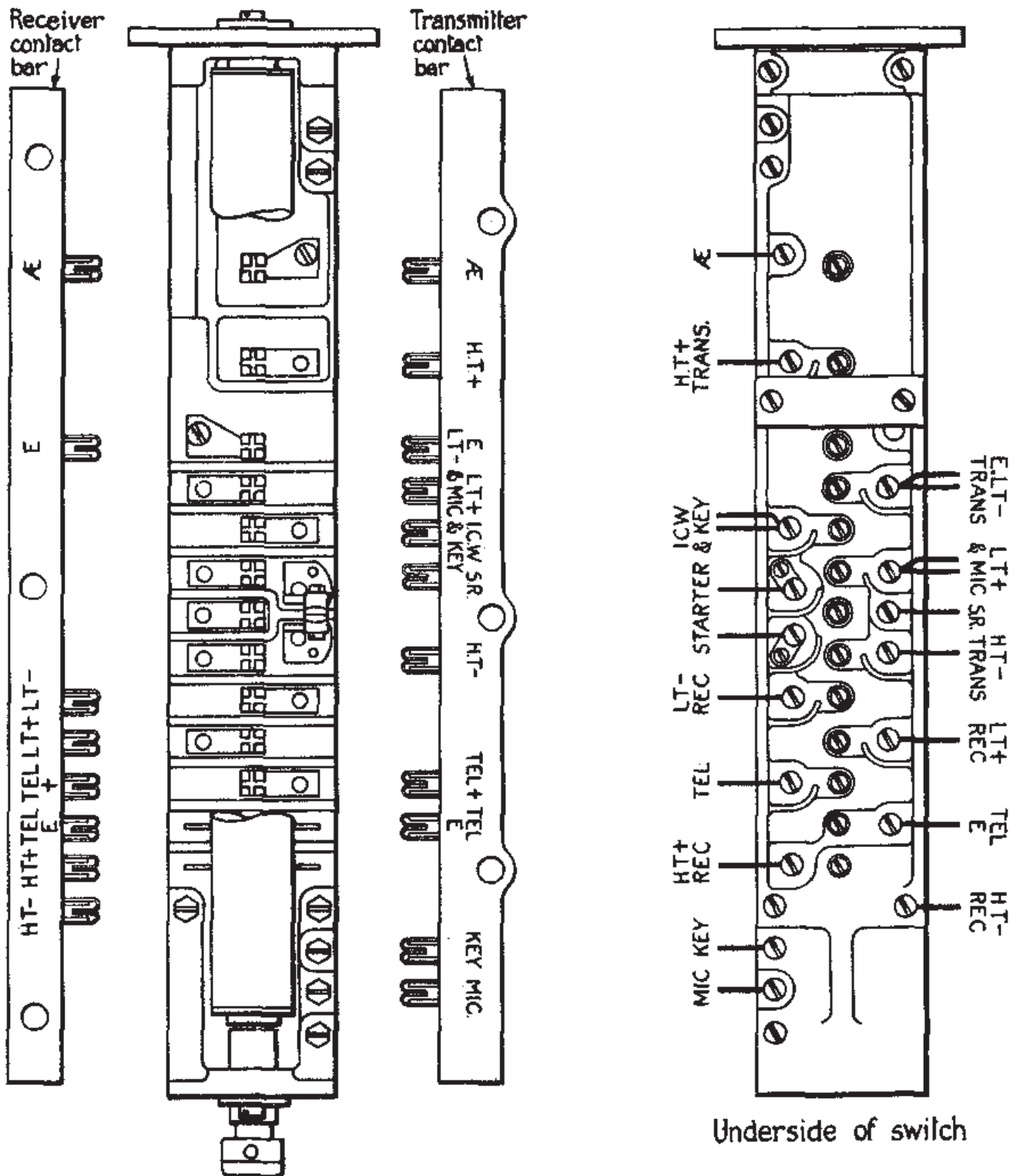


FIG. 6. T.R.1091, SWITCH UNIT TYPE E.
AS WIRED FOR HECTOR INSTALLATION

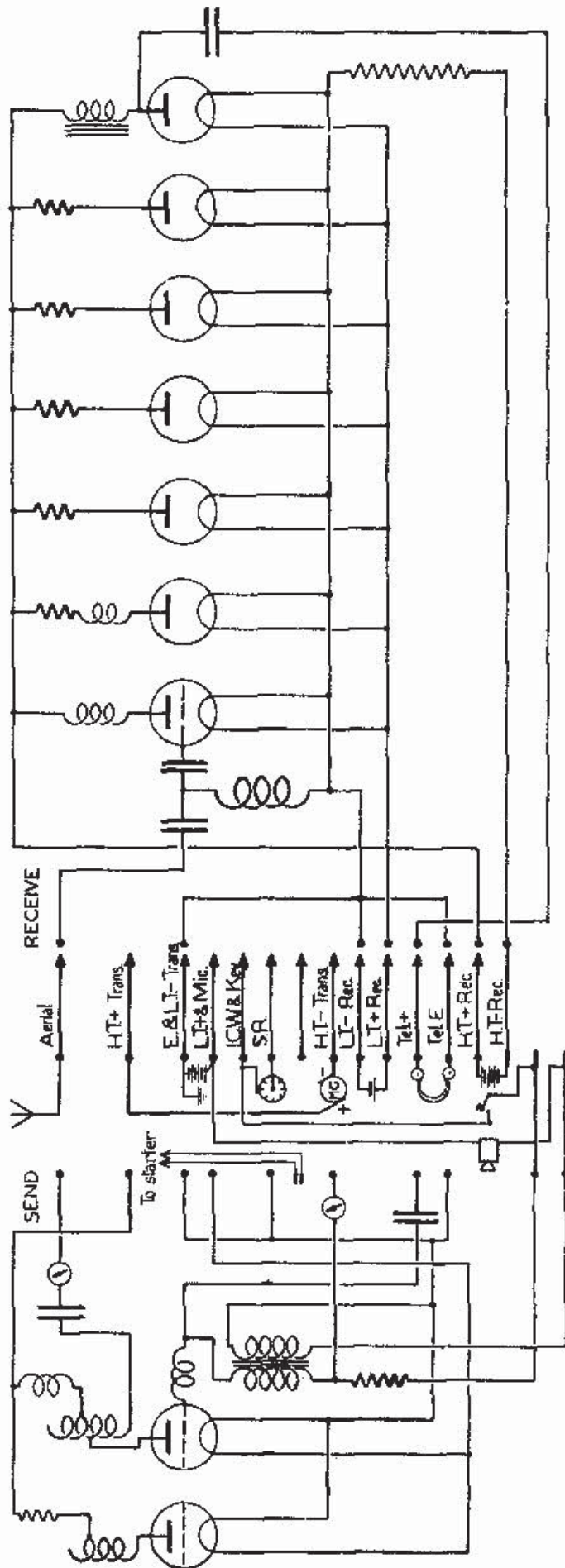


FIG 7, TRANSMITTER-RECEIVER SIMPLIFIED SEND-RECEIVE DIAGRAM

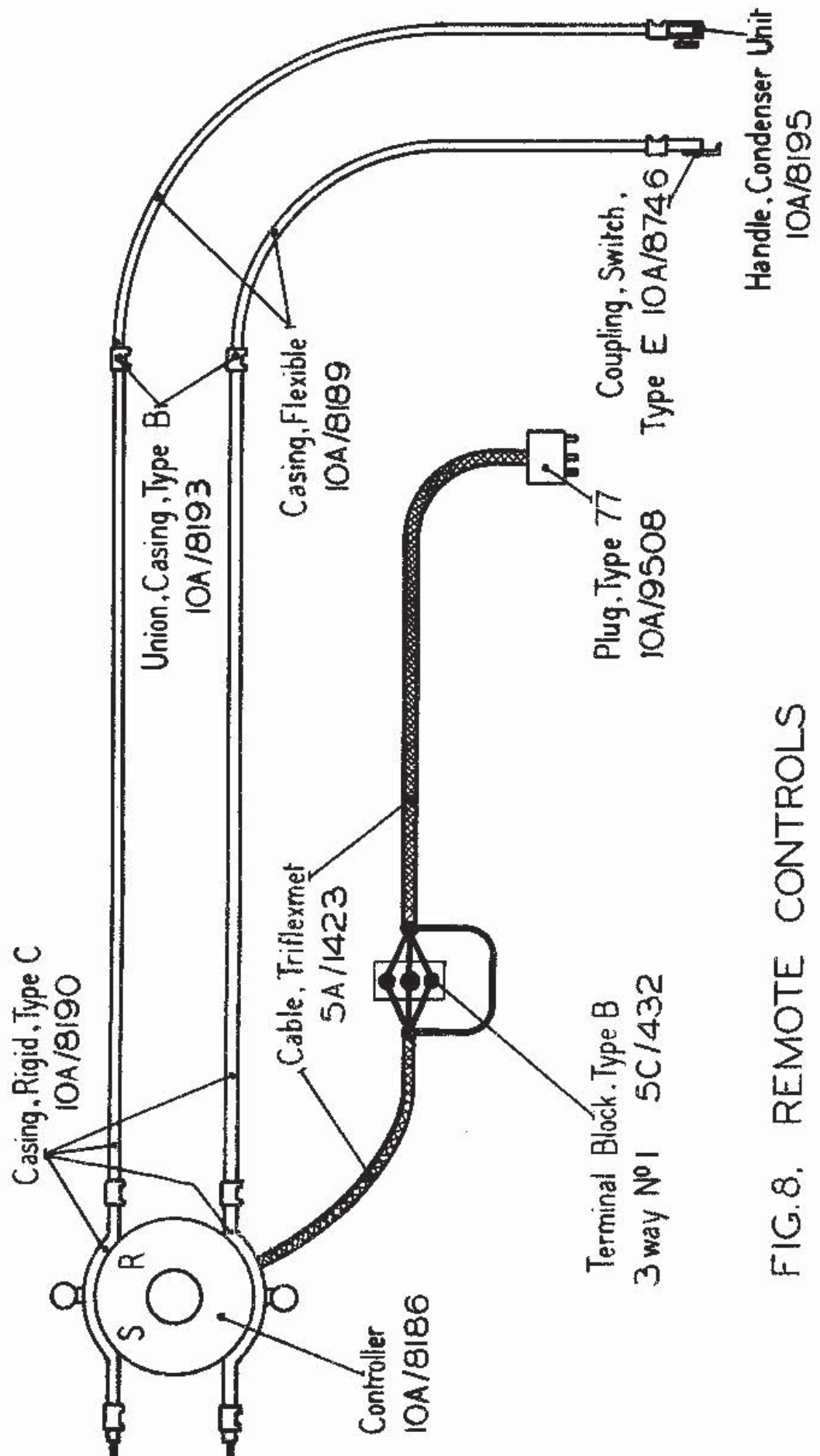


FIG.8. REMOTE CONTROLS

18. The switch is shown in the receive position. It will be seen that the first blade connects the aerial to the receiver. The next blade engages no spring jaw in this position. The third blade connects up the earth circuit to the receiver. The next five blades make no connection in the receive position. The next two make the filament circuit of the receiver. The next two blades connect the telephones to the output circuit of the receiver, and the next blade closes the H.T. + circuit to the receiver. The H.T. — to the receiver is permanently connected.

19. When the switch is moved into the "send" position the first blade transfers the aerial to the transmitter. The next blade closes the H.T. + to the transmitter. Earth and L.T. — are made to the transmitter by the third blade, and the L.T. + and microphone connections are closed by the fourth blade. The fifth blade (I.C.W. and key) is permanently connected to the key and interrupter, and the sixth blade (S.R.) is now connected to negative filament. The seventh blade closes the starter circuit. The next blade completes the H.T. — circuit to the transmitter. The next two blades (L.T. — Rec., L.T. + Rec.) are inoperative in the send position. The telephones which are connected across the next two blades are now connected into the side-tone circuit of the transmitter. The last movable blade (H.T. + Rec.) makes no connection in this position. The two fixed blades at the extreme end which make contact with the corresponding spring jaws on the transmitter, permanently connect the key and the microphone to the transmitter.

Mounting board

20. The mounting board upon which the send-receive switch is fitted consists of two fabric-covered mahogany boards between which four anti-vibration mountings are provided. A hinged lug is provided at each corner of the mounting board. When the transmitter and receiver are placed on the board, the lugs engage projections provided on the right and left-hand side of the transmitter and receiver respectively, and thus secure the instruments at the outer corners. Two retaining clamps are provided on the switch unit, and after the instruments have been placed in position, the clamps are screwed down so as to bear on the top of the contact bars at the side of the transmitter and receiver (*see fig. 1*).

Remote controls

21. The system of remote controls employed on the T.R.1091 is shown in fig. 8. The controller (Stores Ref. 10A/8186) seen in the top left-hand corner of the figure is provided with three controls. The top handle controls the change-over switch and may be left in one of three positions, namely, transmit when in the "S" position, receive when in the "R" position, and "off" when in the intermediate position. The knob in the centre of the controller provides remote volume control, and the bottom handle is for the purpose of tuning the receiver.

22. As can be seen from fig. 8 a switch coupling, a condenser unit handle and a three-pin plug are provided. The switch coupling is connected to the change-over switch handle, the condenser unit handle is connected to the tuning control (3, fig. 16) and the three-pin plug is inserted in the socket (4, fig. 16). When the plug is inserted in the socket a projection on the plug opens a pair of contacts in the receiver and the variable resistance (6, fig. 17) is disconnected. The variable resistance, incorporated in the controller, is introduced into the circuit and movement of the control knob now provides the volume control.

23. The manner in which the remote controls are installed in the aeroplane and the apparatus necessary for coupling them to the receiver are fully described in the chapter dealing with the transmitter T.1083 in this publication. Although the heterodyne condenser knob on the receiver is adapted for remote control, no provision is made for remote control of this in the apparatus shown in fig. 8.

SECTION 2, CHAPTER 3

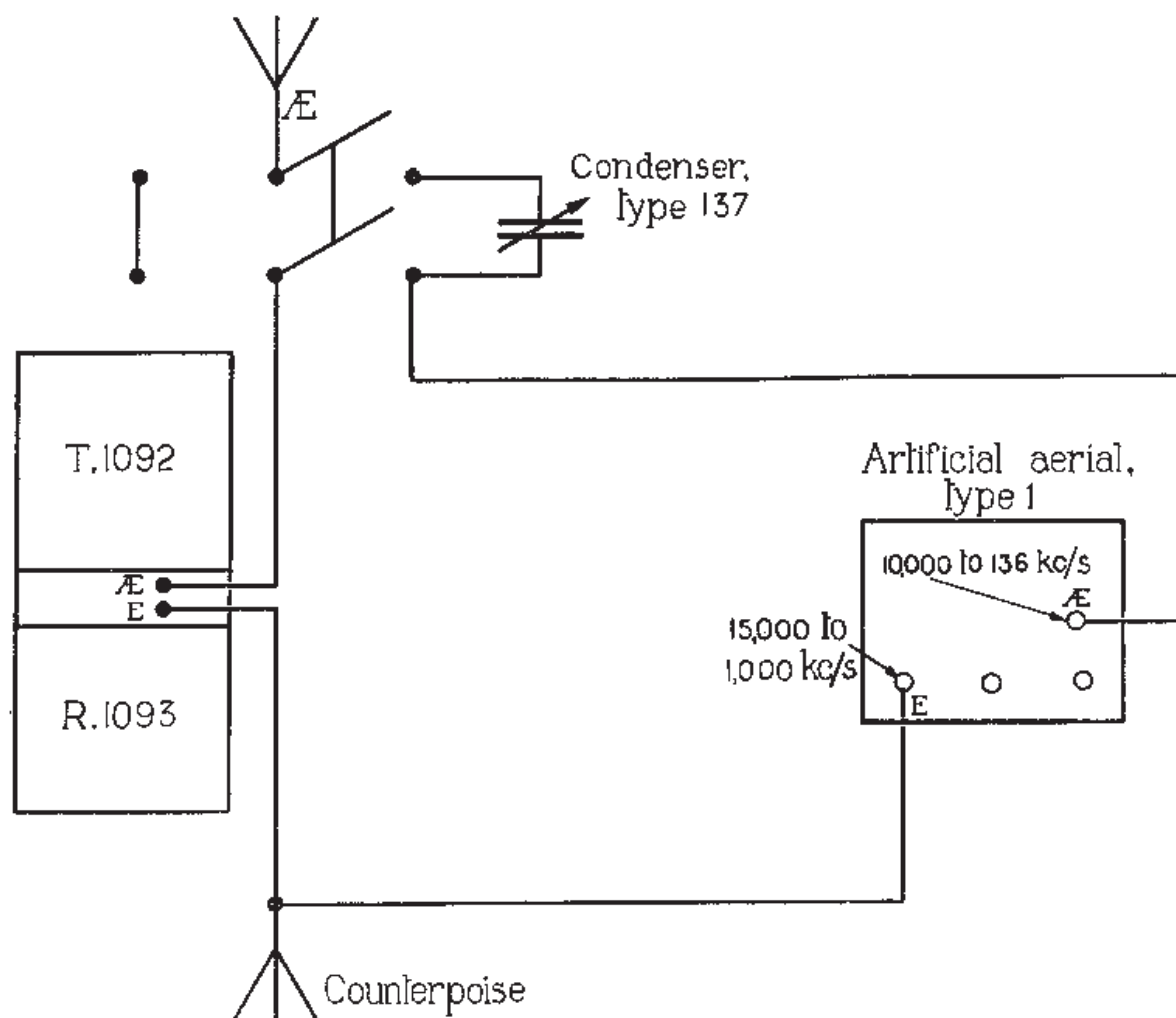


FIG. 9. Listening-testing set.

Testing and listening device

24. In order to provide testing facilities on the T.R.1091 without causing interference with other aeroplanes operating in the vicinity, a device for transmission on reduced power has been developed. It consists of an artificial aerial, Type I, with a change-over switch (Stores Ref. 10A/646) and a variable condenser (Stores Ref. 10A/8042). The arrangement is shown diagrammatically in fig. 9. When the change-over switch is in the left-hand position the aerial terminal of the transmitter is connected to the aerial, and the earth terminal to counterpoise in the usual way, radiation being normal. When the switch is moved into the right-hand position the artificial aerial is connected across the transmitter and the variable condenser is connected in series with the aerial. Radiation is now very much reduced.

25. The method of use may be described in the following way. The switch is first placed in the left-hand position and the transmitter switched on and tuned in the normal way. Next the artificial aerial condenser is set to about $100 \mu\mu\text{F.}$, and the variable condenser, type 137, to about $\frac{1}{3}$ of its maximum value. The switch is now moved into the right-hand position, and the artificial aerial condenser adjusted until maximum aerial current is obtained. It is essential when making these adjustments that the selector switch should be moved to an R/T position in order to avoid excessive inputs. A choice of full or reduced radiation can now be made by moving the change-over switch from one position to the other. When receiving, the send-receive switch on the transmitter is moved to "receive" and the D.P.D.T. change-over switch is moved into the left-hand position.

26. If it is desired to make a change in the amount of radiation when using the artificial aerial, an increase can be effected by increasing the value of the condenser, type 137, or a decrease, by decreasing it, but for any change in this condenser, the artificial aerial must be accurately re-tuned.

CONSTRUCTIONAL DETAILS

Transmitter

27. The transmitter unit (T.1092) is housed in a built-up case approximately 11 in. $\times$ 11 in. $\times$ 8 $\frac{1}{2}$ in. The case is separated into compartments by a metal screen, the amplifier with its associated equipment being housed at one side of the screen and occupying about two-thirds of the space while the master-oscillator is housed at the other and occupies the remaining third. The oscillator compartment is of metal. The amplifier compartment, with the exception of the hinged lid, is of insulating material.

28. All the controls and meters are mounted on the front of the transmitter. Referring to fig. 10, the three meters can be seen at the top. The thermo-ammeter (1) reads 0–2.5 amps. and is in the aerial circuit. The milliammeter (2) has two scales, 0–40 and 0–120 milliamps., and is in the H.T. feed circuit. The meter is connected up to the selector switch in such a way as to enable the 0–40 scale to be used when in the "tune" position and the 0–120 scale to be used in the R/T, I.C.W. and C.W. positions. The thermo-ammeter (3) reads 0–3 amps. and is connected in the grid filament circuit of the master-oscillator.

29. Beneath the master-oscillator thermo-ammeter is the master-oscillator range switch (4). This is a four-position barrel-type switch, the four positions being engraved on the panel 1,222–1,364 kc/s, 1,364–1,539 kc/s, 2,000–2,500 kc/s and 2,500–3,409 kc/s. The first two engravings (1,222–1,364 kc/s and 1,364–1,539 kc/s) are filled in green and the other two (2,000–2,500 kc/s and 2,500–3,409 kc/s) are filled in yellow. The colours are used to associate them with the appropriate fine-tuning control. The control (5) is the fine tuning for the "green" ranges. The control (6) is the fine tuning for the "yellow" ranges. These two fine tuning controls have the engravings on the panel filled in with the appropriate colour. The upper fine tuning control (5) effects tuning on the 1,222–1,539 kc/s range by moving a rotor within the inductance. The insulated shaft carrying the rotor extends through the panel and carries a gear wheel which is driven by a worm carried in a bracket on the front of the panel. The worm is rotated by means of a milled knob. The bracket also carries a spring-loaded plunger which can be engaged in any one of ten holes drilled around the milled knob. A metal disc, engraved around approximately half its face with the figures 1–13, is attached to the main spindle and this disc reads against a datum line on the panel. The worm wheel makes one complete revolution for each of the divisions on the disc and the barrel of the milled knob is engraved with the figures from 0–9. A rotation of the milled knob through one of its divisions thus moves the rotor coil through approximately $\frac{1}{130}$ th of its travel.

30. The lower fine tuning control (6) effects tuning on the 2,000–3,409 kc/s range through a continuously variable tap on the inductance. The shaft which operates the contact on the inductance is extended through the panel and carries a milled control handle engraved 0–360. One revolution of the handle corresponds to a complete turn of the inductance. An additional indicating device shows, at a window in the panel, a figure indicating the number of turns of inductance in the circuit. A locking device is also provided.

31. Similar provision for tuning is made on the amplifier. The switch (7) is the amplifier range switch. It is a similar type of switch to that on the master-oscillator and the engravings are filled in green and yellow as on the master-oscillator switch. The fine tuning device (8) on

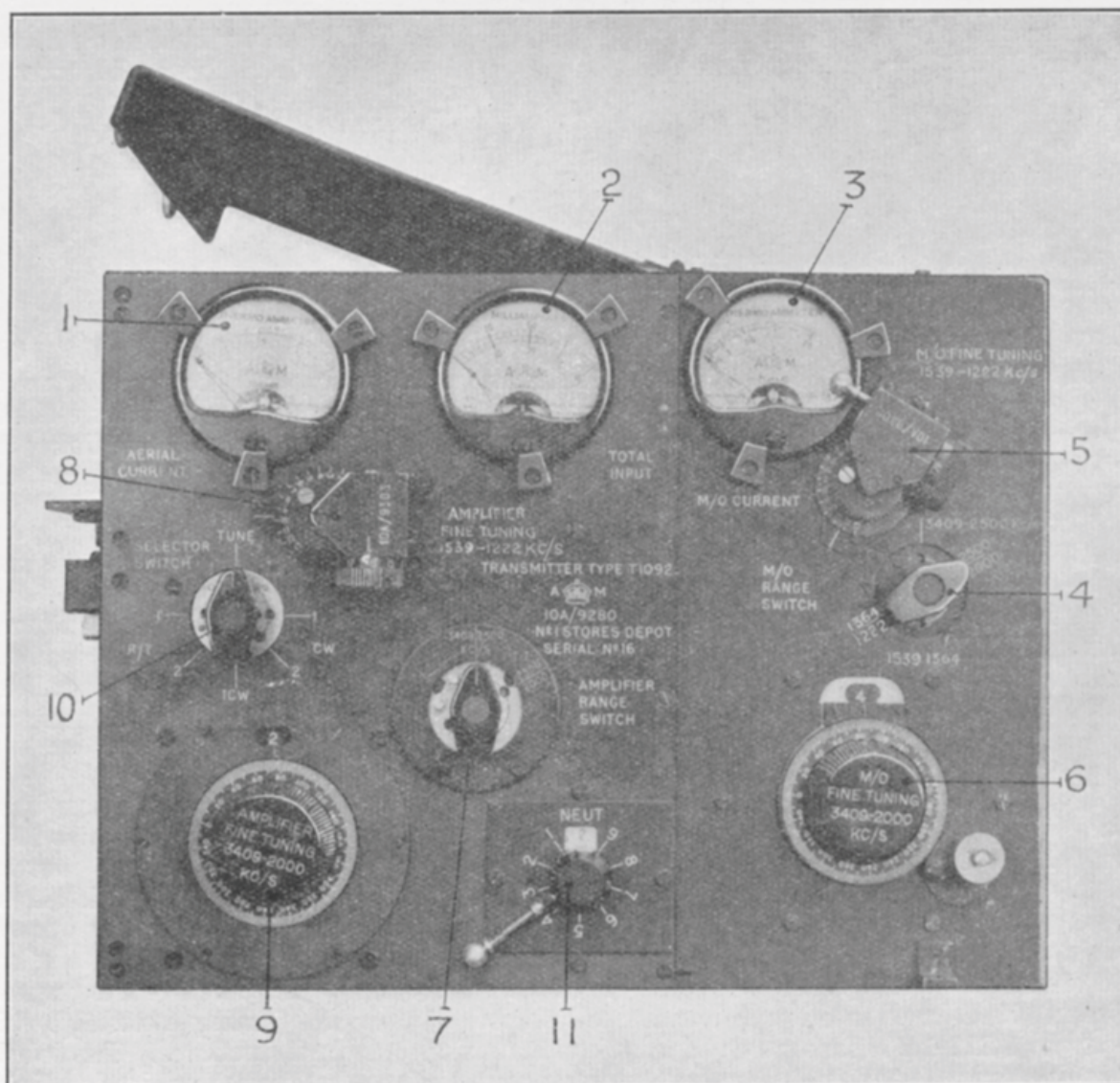


FIG. 10. Transmitter T.1092, front view.

the 1,222–1,539 kc/s range is of similar construction to the control (5) described for the master-oscillator except that no locking device is provided. The fine tuning control handle (9) is similar to the control (6) described for the master-oscillator. No locking device is provided.

32. The only other controls on the panel are the selector switch (10) and the neutralizing condenser control (11). The selector switch is a six-position barrel type switch, and the panel is engraved TUNE, R/T 1–2, I.C.W., C.W. 1–2. In the tune position the amplifier H.T. circuit is broken, the H.T. feed milliammeter is placed on the 0–40 mA range, the key and interrupter are short-circuited and the total grid bias resistance is included. In positions R.T.1 and R.T.2 the key and interrupter are again short-circuited, the microphone circuit is energized, the amplifier H.T. circuit is closed and the H.T. milliammeter is connected on the 0–120 mA range. In the I.C.W. position the secondary of the microphone transformer is short-circuited, the short-circuit is removed from the interrupter and the key, the H.T. feed to the amplifier is completed and the H.T. milliammeter is connected on the 0–120 milliamps range. In the C.W.1 and C.W.2 positions the interrupter is short-circuited, the secondary of the microphone transformer is short-circuited, the H.T. feed to the amplifier is closed and the milliammeter is placed on its 0–120 milliamps range. Different values of grid bias are provided in each of these positions

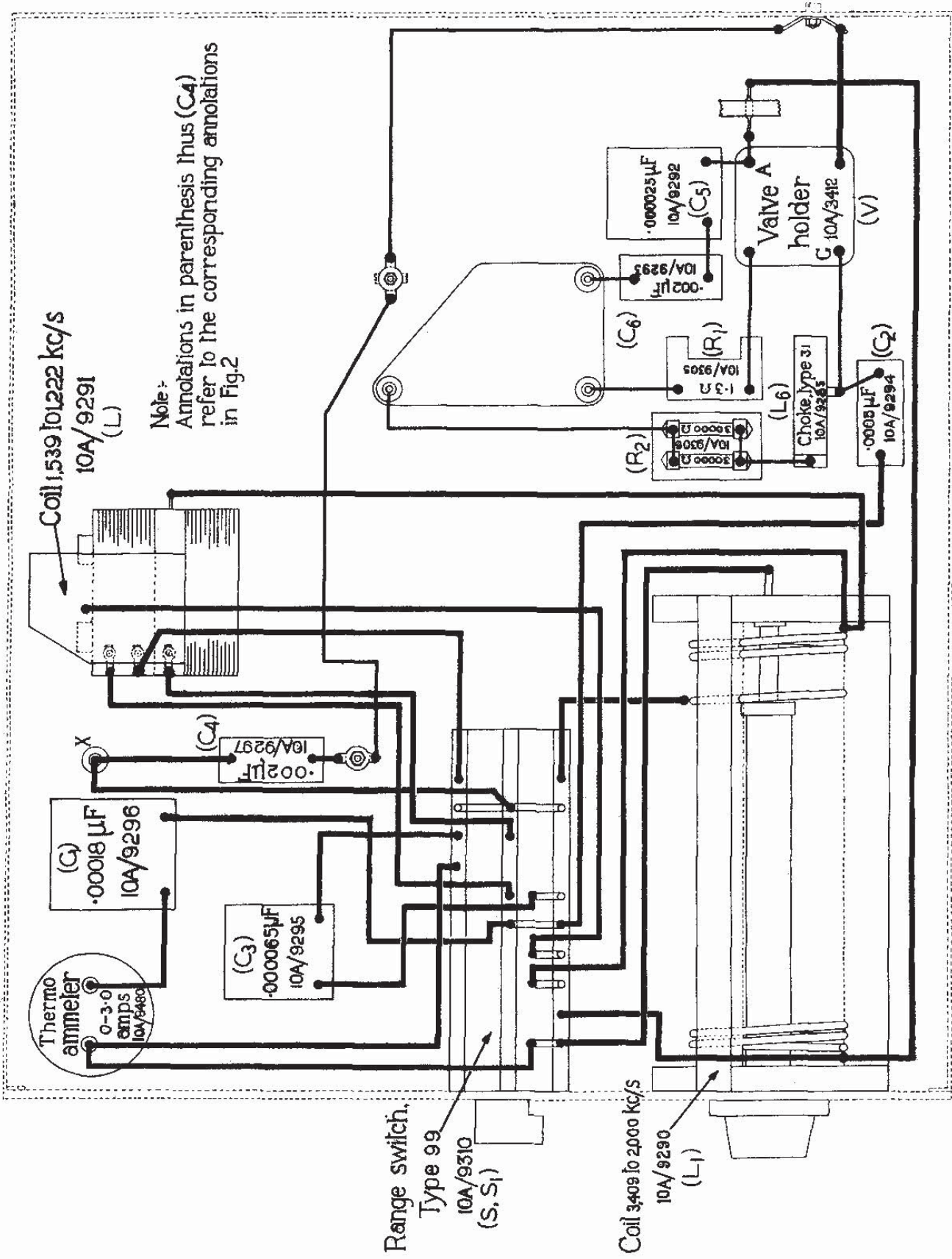


FIG.12, BENCH WIRING DIAGRAM , T.1092 M/O UNIT

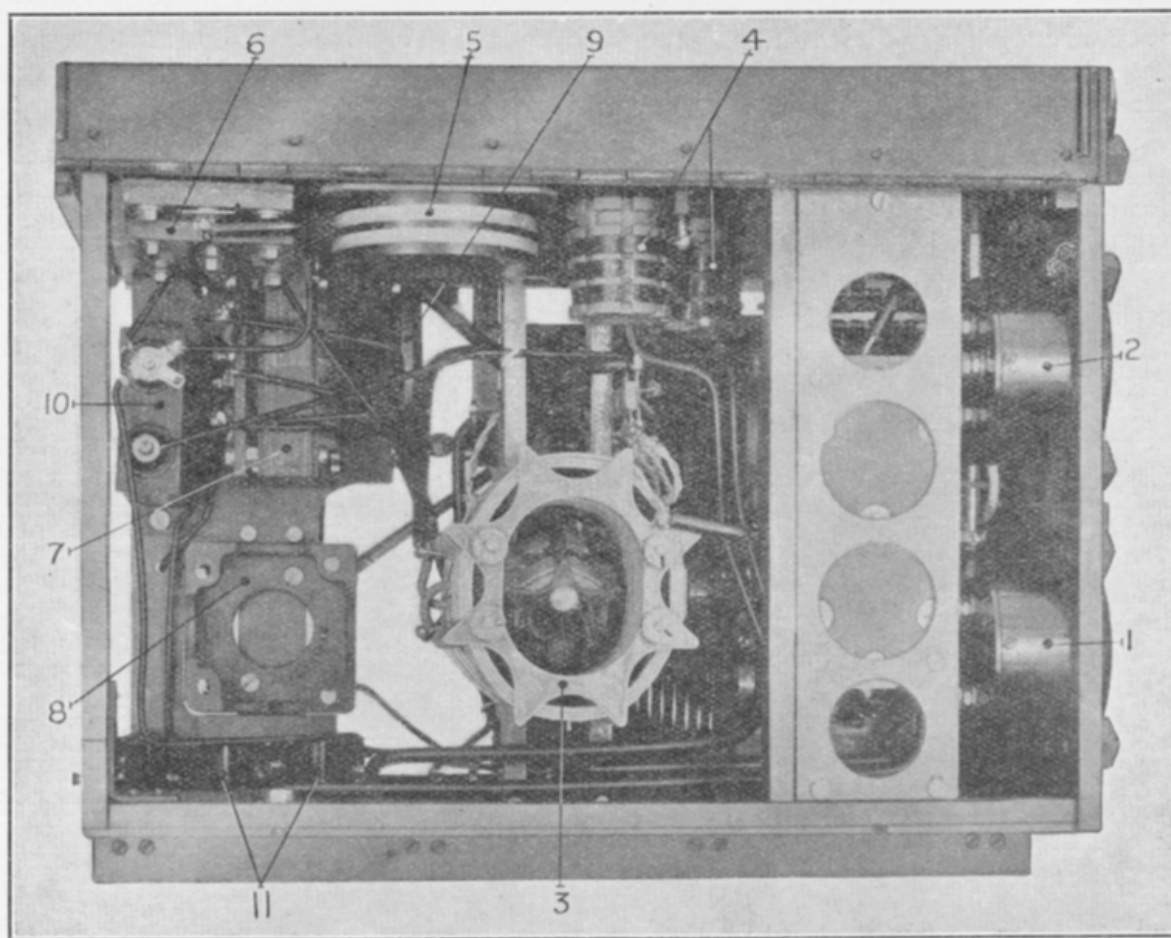


FIG. 11. Transmitter T.1092, plan view.

(see fig. 5). The neutralizing condenser control (11) is provided with a serrated knob on the front of the panel. A plate on the panel is engraved with figures from 1–9 and an indicating device shows, at a window, a figure giving the number of complete turns of the knob. A spring-loaded plunger is provided. This is capable of engaging with any one of the ten serrations in the knob in order to lock the condenser in the correct position.

33. Three views of the interior of the transmitter are shown in figs. 11, 13 and 14, and two bench wiring diagrams in figs. 12 and 15. Referring to fig. 11, which is a plan view of the transmitter with the cover raised and two panels removed, the 0 to 2·5 aerial ammeter (1) can be seen in the right-hand bottom corner, while adjacent to it can be seen the 0–40 and 0–120 milliammeter (2) which records the total input. In the centre foreground can be seen the amplifier low frequency coil (3) with its variometer. The two resistances (4) seen above this coil are connected in series and have a value of 50,000 ohms each. They constitute the resistance R_3 in the theoretical circuit diagram fig. 2.

34. The choke (5) seen to the left of these resistances is a high-frequency choke in the H.T. + circuit, while the condenser (6), adjacent to it, has a value of $\cdot 002\mu\text{F}$ and is connected between the choke and the negative filament lead. In the background can be seen the microphone transformer (7), and beneath it the amplifier valve-holder (8). The choke (9), to the right of the microphone transformer, is the amplifier grid choke and it is connected in the grid circuit of the amplifier valve. The large $\cdot 5\mu\text{F}$ condenser (10) is shunted across the series grid bias resistances. The two condensers (11) in the bottom left-hand corner are each $\cdot 002\mu\text{F}$; the

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one on the right is connected across the terminals marked TEL+ and KEY, while the one on the left is connected in series with the telephones between the microphone transformer secondary and earth.

35. Fig. 13 is an inside view of the transmitter showing the components associated with the M/O valve. In the bottom right-hand corner can be seen the M/O valve-holder (1) and two condensers (2) and (3), having values of $\cdot 000025\mu\text{F}$ and $\cdot 002\mu\text{F}$ respectively. These two condensers form the coupling between the M/O and amplifier valve. The $\cdot 0005\mu\text{F}$ condenser (4) is connected in the grid circuit of the M/O valve. The two 30,000 ohm resistances (5) are connected in parallel to give a 1,500 ohm resistance which is connected to the grid of the valve, in series with the choke (6).

36. The M/O high-frequency coil (7) can be seen in the left-hand foreground. The variable tap is connected to one terminal of the 0-3 ammeter. The other terminal of the ammeter is connected through the $\cdot 00018\mu\text{F}$ condenser (8) to the grid circuit of the valve. The coil itself is wound with $\frac{1}{8}$ in. o/d 22 s.w.g. silver plated copper tube on a former of composite insulating material. It has 35 turns wound as a right-hand thread. The variable tap is the usual laminated brush bearing on the inside of the coil. The various tapping points on the coil and its connection relative to the rest of the circuit may be seen in the theoretical circuit diagram fig. 2, and in the bench wiring diagram, fig. 12.

37. Immediately above the coil is the M/O range switch (9). It is capable of being set in any one of four positions, 3,409 to 2,500 kc/s, 2,500 to 2,000 kc/s (yellow), 1,539 to 1,364 kc/s and 1,364 to 1,222 kc/s (green). To the right of the switch can be seen the M/O low-frequency coil (10). The various tapping points from the coil to the range switch may be seen in the theoretical circuit diagram, fig. 2. The single insulated lead (11) on the right of the coil is the connection to the rotor of the coil. The stator of the coil is wound counter-clockwise looking from the rotor end and consists of 11 sections. The first section has $3\frac{1}{2}$ turns, and 4th and 5th sections have 4 turns each and the remainder have 3 turns each. The wire used is 27/38 Litz wire, each

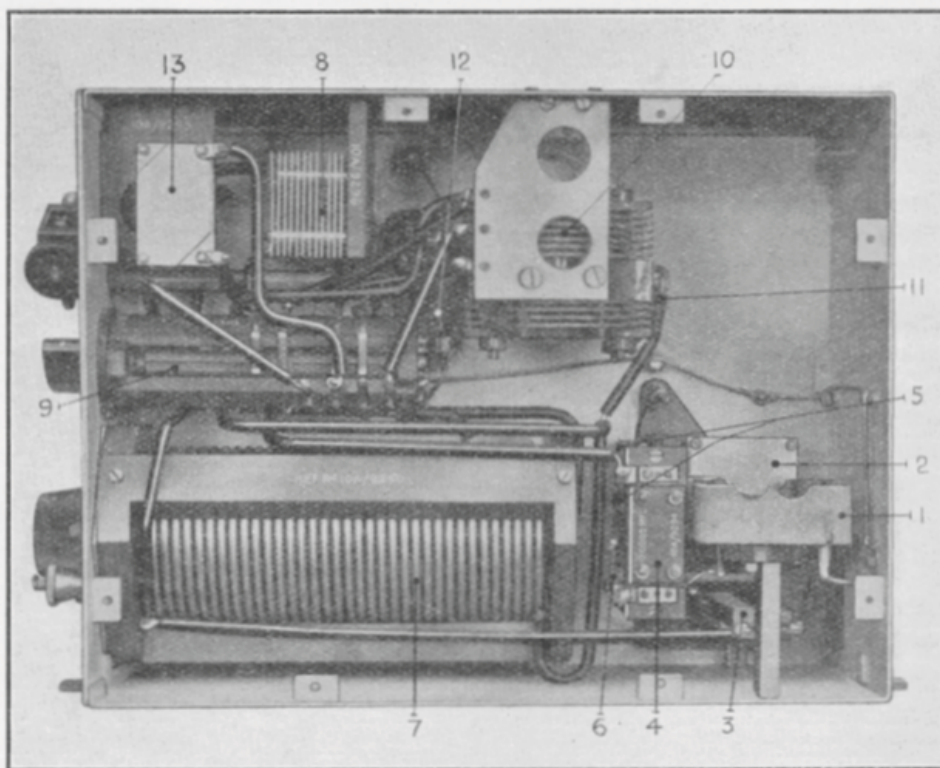
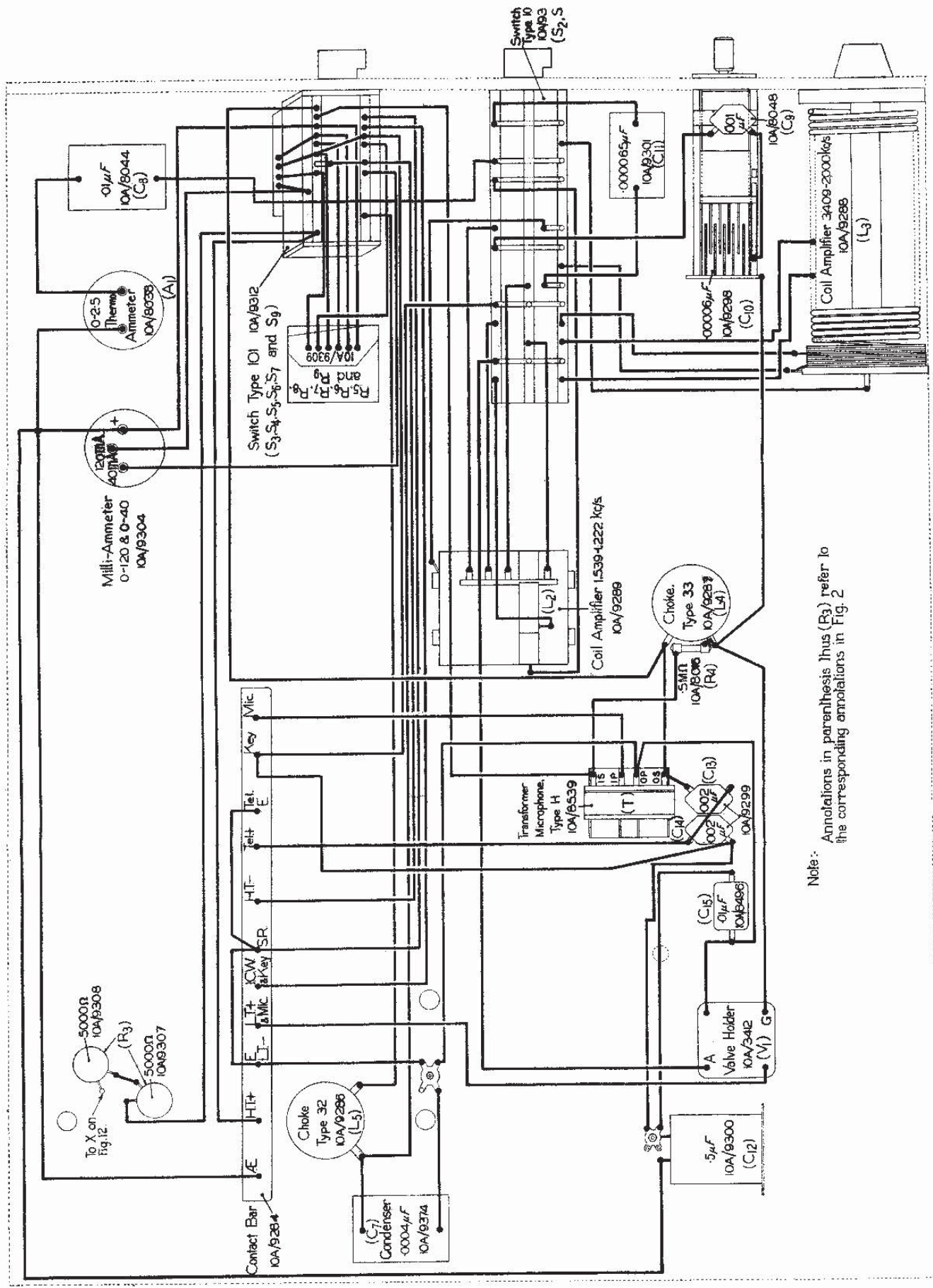


FIG. 13. Transmitter T.1092, viewed from right.



Note: Annotations in parenthesis thus (R3) refer to the corresponding annotations in Fig. 2

FIG.15, BENCH WIRING DIAGRAM, T.1092, AMPLIFIER UNIT

strand being single silk-covered and all 27 strands being double silk-covered. The rotor is wound with 27/40 Litz wire in ten sections. The first four sections have 2 turns per section, the next two have 3 turns per section, and the remaining four have 2 turns per section. The $\cdot 002\mu\text{F}$ condenser (12) which can be seen in the background forms an R/F by-pass for the oscillatory component of the anode current. The $\cdot 000065\mu\text{F}$ condenser (13) seen in the top left-hand corner of fig. 13 is shunted across the M/O inductance for certain frequencies and is represented by C_3 in the theoretical circuit diagram, fig. 2.

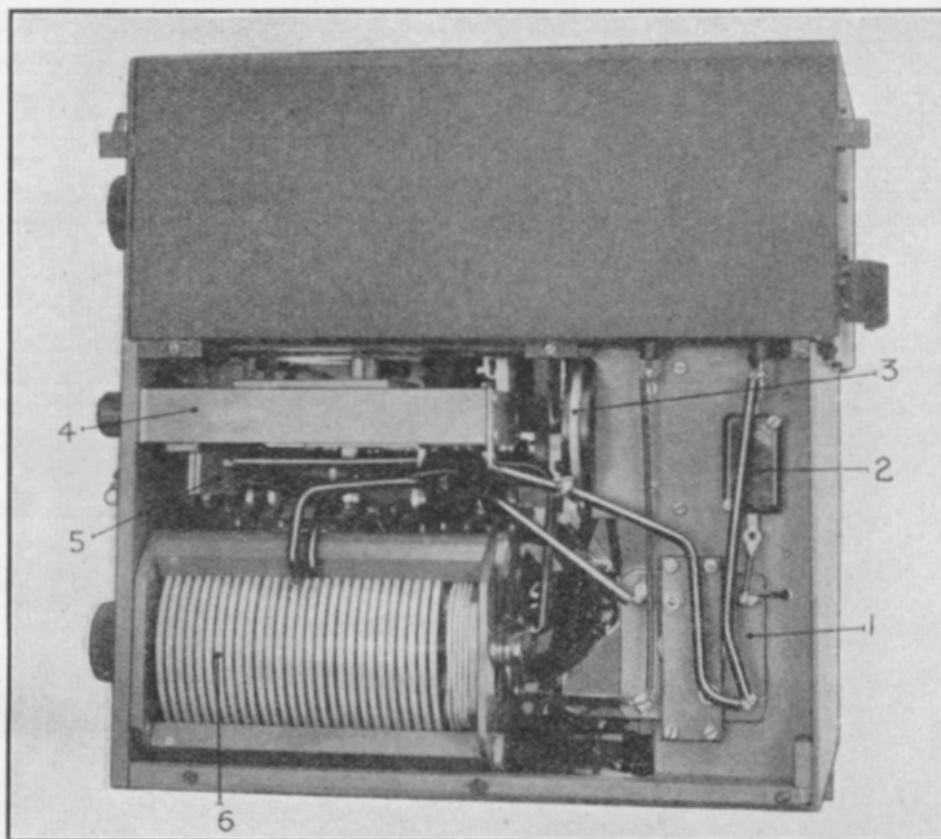


FIG. 14. Transmitter T.1092, underside view.

38. Fig. 14 is an underside view of the components associated with the amplifier valve. The valve-holder (1) can be seen in the bottom right-hand corner, while the $\cdot 01\mu\text{F}$ condenser (2) seen just above it is connected across the contacts engraved S.R. and KEY and is represented by the condenser C_{15} in fig. 2. The choke (3) is in the grid circuit of the valve. In the top left-hand corner can be seen the neutralizing condenser (4) while the $\cdot 001\mu\text{F}$ condenser (5) below it is connected between the neutralizing condenser and a terminal on the range switch.

39. The amplifier short wave coil (6) can be seen in the bottom left-hand corner. It consists of 28 turns of 22 s.w.g. silver plated copper tube $\frac{1}{8}$ in. o/d, wound on a composite insulating material former. Two further windings are provided on the same former. One has 4 turns of 16 s.w.g. double cotton-covered H.C. copper wire and the other has 7 turns of 24 s.w.g. double silk-covered H.C. copper wire. The main coil has a movable tap in the form of a laminated brush which makes contact with the various turns from the inside of the coil. The various connections from the coil may be seen in figs. 2 and 3. The amplifier low frequency coil can be seen in the centre background—this has been referred to in a previous paragraph.

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Receiver

40. Referring to fig. 16, the volume control handle (1) can be seen in the top left-hand corner of the receiver. This consists of a potentiometer device, the moving contact of which is connected to the screen grids of the radio-frequency valves thus giving control of the potential applied thereto. To the right of this is the handle (2) of the heterodyne condenser. This is provided with a coupling which may accommodate a remote control fitting to allow the heterodyne note to be adjusted from a remote position. Coupling is effected by means of a square spring-loaded plunger on the fitting engaging with the squared hole in the centre of the handle.

41. Beneath the heterodyne control is the handle (3) of the ganged condensers which tune the radio-frequency circuits. This is arranged for remote control. To the left of this is a 3-point socket which provides for remote control of volume. The 3-point socket (4) receives a plug which is connected by 3-core flexible cable to a remote potentiometer. In addition to the three electrical connections a fourth hole is provided on the socket and a fourth pin on the plug, the purpose of which is to provide for disconnection of the local potentiometer. This is accomplished by providing a switching device at the rear of the socket so that when the plug is inserted the fourth pin opens the contacts.

42. Near the base of the receiver are situated the heterodyne filament switch (5) and the frequency change switch (6). The former open-circuits the heterodyne valve filament circuit when C.W. is not required. The latter is a multiple switch, the handle of which is carried on the end of a squared spindle which extends to the rear of the receiver. When the handle is rotated three 4-point switches (5, 10 and 16, fig. 19) are operated simultaneously. The first switch is

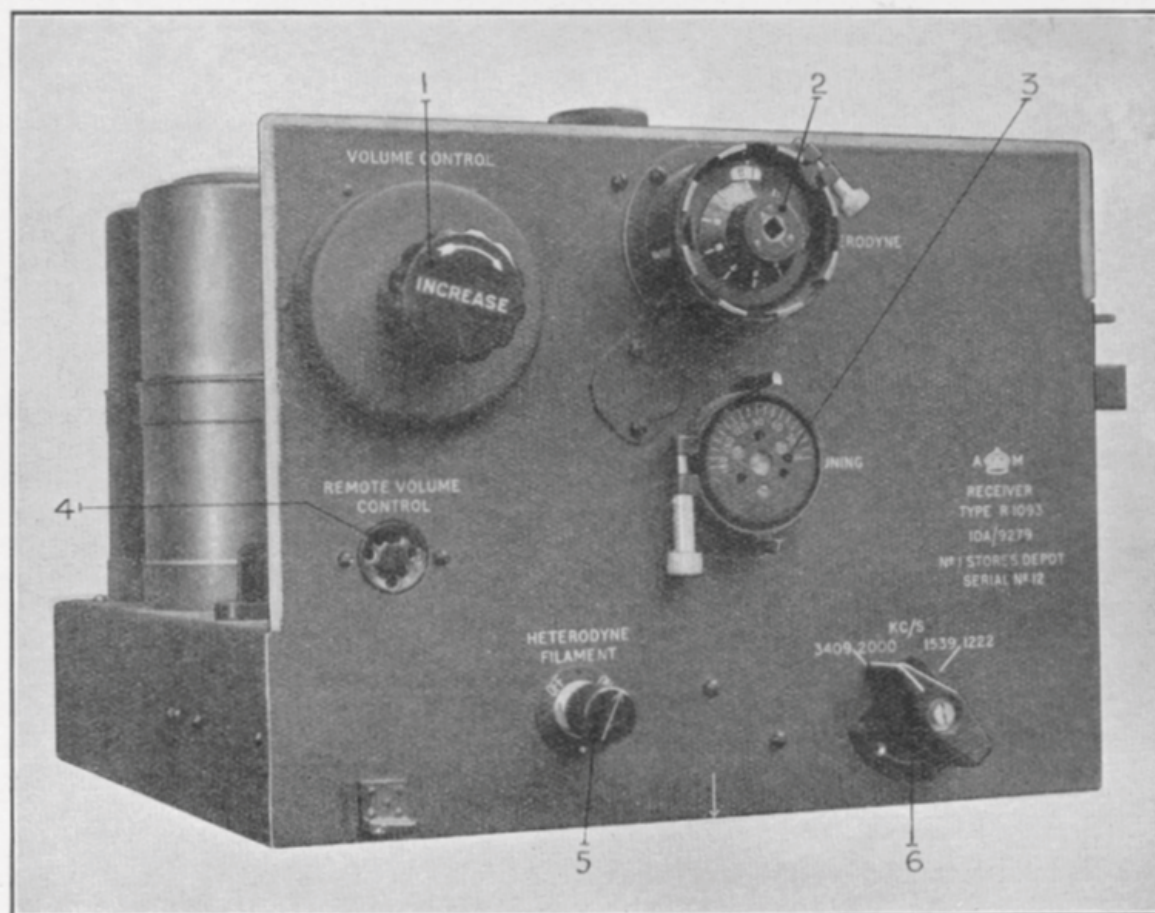


FIG. 16. Receiver, R.1093, front view.

associated with the aerial inductances, the second switch is associated with the anode inductances of the first R/F valve and the third switch is associated with the anode inductances of the second R/F valve.

43. The action of the switch can be explained in the following way. When in the low-frequency position, the inductance is connected across the grid-filament circuit of the first valve and the high-frequency inductance is disconnected. When moved into the high-frequency position, the inductance is connected across the grid-filament circuit, and the low-frequency inductance is short-circuited. In a similar way the anode inductances of the first R/F valve are switched in and out, the low-frequency inductance being short-circuited when the high-frequency inductance is in circuit. The anode inductances of the second R/F valve are switched in a similar manner.

44. Three interior views of the receiver are given in figs. 17, 18 and 19, and a bench wiring diagram in fig. 20. Referring to fig. 17, which is a plan view of the receiver with the cover removed, the two screening cans (1) for the screen-grid valves can be seen in the top right-hand corner. The three valve-holders to the left are the detector (2), 1st A/F (3), and 2nd A/F (4). The unit in the top left-hand corner is the volume control. It consists of a 50,000 ohm variable resistance (6) which is controlled by the handle (1, fig. 16). When the volume is remotely controlled, a plug is inserted in the socket (4, fig. 16) and a pin on this plug opens the contacts of the switch (5), thus cutting out the 50,000 ohm resistance (6) incorporated in the receiver.

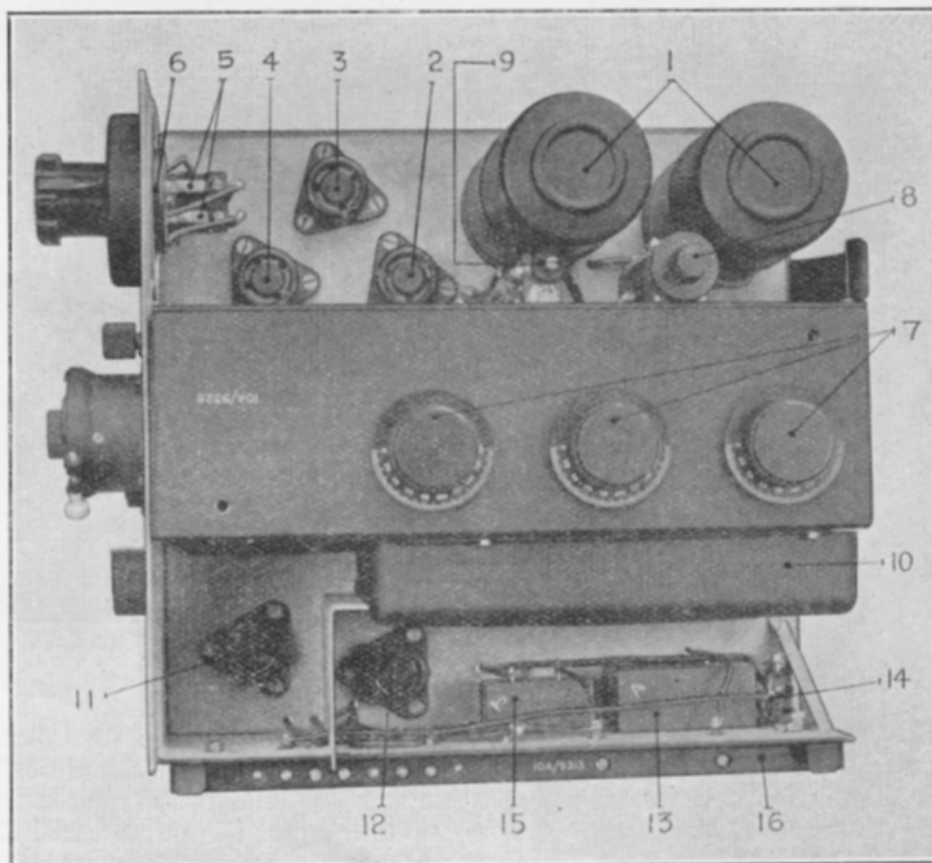


FIG. 17. Receiver R. 1093, plan view.

45. The three tuning knobs (7) project through the cover and control the condensers (C_2 , C_{10} and C_{19} , fig. 5). The 0-10 $\mu\mu\text{F}$ variable condenser (8) has a control knob which projects through the cover. This condenser is connected between the anodes of the 1st and 2nd R/F

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valves. The 135 ohm variable pre-set resistance (9) is connected across the filament leads of the detector valve. The tapping point is connected through a $\cdot 25 \text{ M } \Omega$ resistance to the grid of the same valve.

46. The high-frequency and low frequency coils for the aerial and 1st and 2nd R/F valves are housed under the cover (10). These coils are indicated as L_1-L_2 , L_3-L_4 and L_5-L_6 respectively in fig. 5. The cover may be removed for inspection of these coils by undoing four screws. Each of the three high-frequency coils is wound on a former of mica-loaded Trolitol having a dust-iron core. The winding consists of 26 turns of Litz wire, 9/48 enamel double silk-covered copper, giving an inductance of 20 Mics. $\pm \cdot 5$. Each low-frequency coil is wound on a former and core of similar material. The winding consists of 40 turns of Litz wire, 9/48 enamel double silk-covered copper, wound in one slot, the inductance being 60 Mics. ± 1 .

47. The valve-holders (11) and (12) are for the heterodyne and output valves respectively. The $2 \mu\text{F}$ condenser (13) is shunted across the centre-tapped 180 ohm resistance (14). One end of this resistance is connected to H.T.— while the other end is connected to earth. The $\cdot 5 \mu\text{F}$ condenser (15) is connected between the earthed end and the centre-point of the resistance. The contact bar (16) is provided with 8 spring-jaw contacts engraved, from the right, $\text{\AA}$, E, L.T.—, L.T.+, TEL+, TEL. E, H.T.+ and H.T.—. These contacts engage the appropriate blades on the send-receive switch when the receiver is in position.

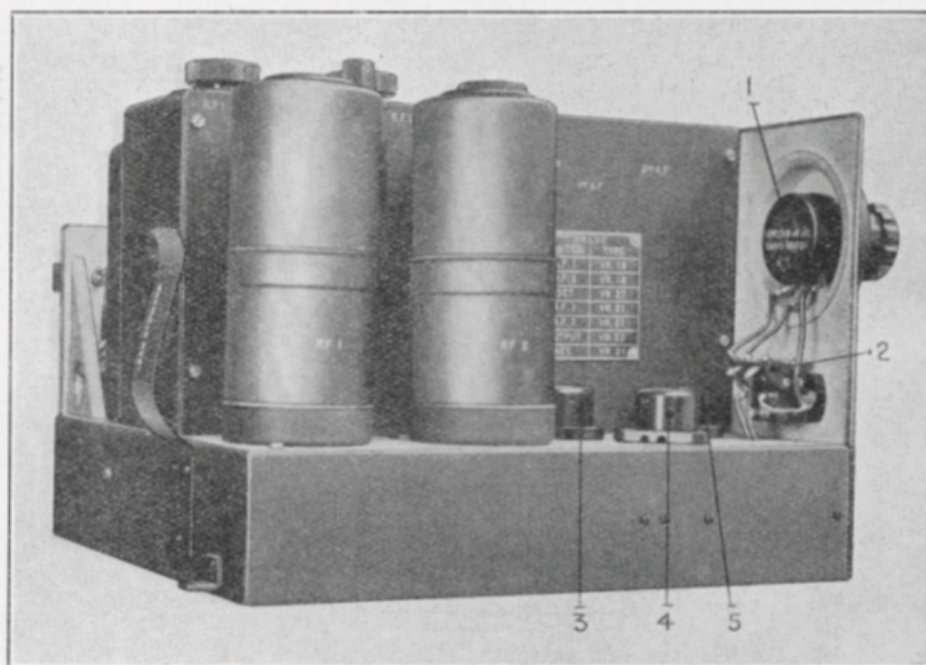


FIG. 18. Receiver R.1093, viewed from the left.

48. Fig. 18 is an inside view of the receiver from the left-hand side, the volume control (1) can be seen in the top right-hand corner and below it the spring contact unit (2) for remote volume control. The three valve-holders (3), (4) and (5) are holders for the detector valve and the 1st and 2nd A/F valves respectively. The screening cans for the 1st and 2nd R/F valves can be seen on the left-hand side appropriately engraved.

49. Fig. 19 is an underside view of the receiver. The components are divided into four groups suitably screened by metal panels on which some of the components are mounted. The group on the left is associated with the 1st R/F valve and comprises a valve-holder (1), a $1 \cdot 5 \text{ ohm}$ resistance (2) in the negative filament lead, two $\cdot 5 \mu\text{F}$ condensers (3) arranged one above the other, a group of resistances and condensers (4) and a frequency change-over switch (5).

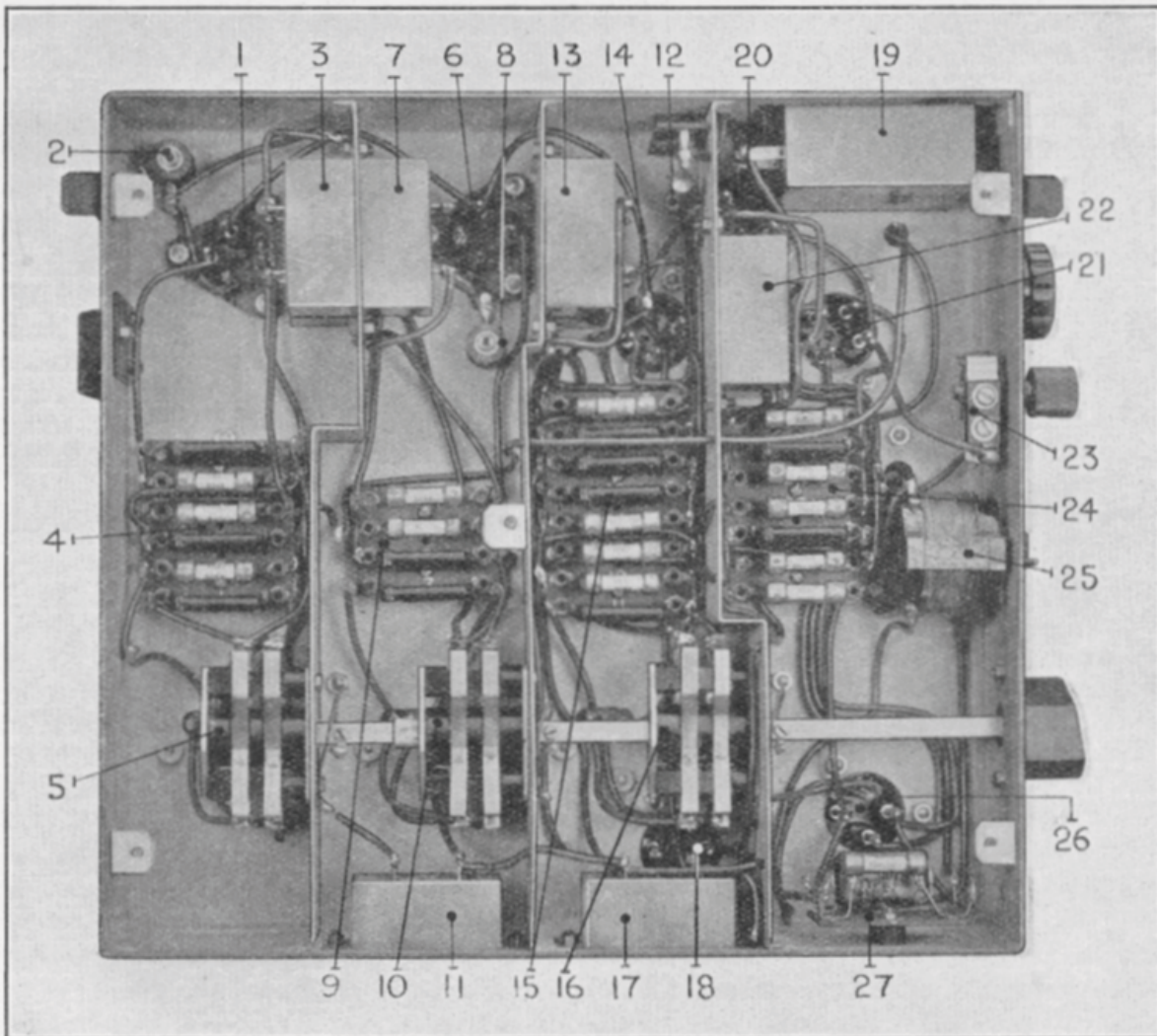


FIG. 19. Receiver R.1093, underside view with the cover removed.

50. Of the two $\cdot 5 \mu\text{F}$ condensers (3), one is connected between one side of the 100,000 ohm resistance R_3 (see fig. 5) and earth, and the other $\cdot 5 \mu\text{F}$ condenser is connected between the other side of the resistance and earth. The group of condensers and resistances (4), comprises three resistances and three condensers. These components are numbered from 1 to 6, on their mounting panel, reading from the bottom. The condenser numbered 1 has a value of $\cdot 00005 \mu\text{F}$ and is connected between one terminal of the change-over switch and one side of the $\cdot 5 \text{ M } \Omega$ resistance numbered 2. This is the aerial coupling condenser. The other side of the $\cdot 5 \text{ M } \Omega$ resistance is connected to earth. The condenser numbered 3 has a value of $\cdot 00005 \mu\text{F}$ and is connected across the low-frequency coil (L_2 , fig. 5). The next resistance numbered 4 has a value of 100,000 ohms and is the resistance referred to previously connected between the two $\cdot 5 \mu\text{F}$ condensers (3). The resistance numbered 5 has a value of $\cdot 5 \text{ M } \Omega$ and is connected between the grid of the valve and earth. The condenser numbered 6 has a value of $\cdot 0001 \mu\text{F}$ and is indicated by C_7 in the theoretical circuit diagram (fig. 5).

51. The group of components in the second section comprises the 2nd R/F valve-holder (6), a $\cdot 5 \mu\text{F}$ condenser (7) connected between the screen grid and earth, a $1\cdot 5 \text{ ohm}$ resistance (8) connected in the negative filament lead of the valve, a group of condensers and resistances (9) numbered from 7 to 10, reading from the bottom, a frequency change-over switch (10) and a $\cdot 5 \mu\text{F}$ condenser (11) represented by C_8 in fig. 5.

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52. In the group of condensers and resistances (9), the bottom condenser numbered 7 has a value of $\cdot 00005 \mu\text{F}$ and is connected across the low-frequency coil (L_4 , fig. 5). The next condenser numbered 8 has a value of $\cdot 0003 \mu\text{F}$ and is the coupling condenser between the 1st and 2nd R/F valves. The resistance numbered 9 has a value of 50,000 ohms and is connected between the screen grid of the 2nd R/F valve and the centre-point of the volume control. The resistance numbered 10 has a value of 500,000 ohms and is connected in the grid circuit of the 2nd R/F valve. The $\cdot 5 \mu\text{F}$ condenser (11) seen at the bottom is an isolating condenser in the H.T. + lead and is represented by (C_8 in fig. 5).

53. Among the group of components in the third section is a resistance (12) which has a value of $2 \text{ M } \Omega$ and is the grid stopper resistance for the 1st A/F valve. Of the two $\cdot 5 \mu\text{F}$ condensers (13), which are arranged one above the other, the top one is the R/F by-pass condenser (C_{23} , fig. 5), and the bottom one is the condenser (C_{20} , fig. 5). The detector valve-holder (14) can be seen above a group of condensers and resistances (15). The frequency change-over switch (16) can be seen above the $\cdot 5 \mu\text{F}$ condenser (17) which is the R/F by-pass condenser (C_{22} , fig. 5). While the output valve-holder (18) can be seen between these two last mentioned items.

54. The group of condensers and resistances (15) is numbered from 11 to 18 reading from the bottom. The first condenser has a value of $\cdot 00005 \mu\text{F}$ and is connected across the low-frequency coil (L_6 , fig. 5). The 1,000 ohm resistance above it is connected in the anode circuit of the second R/F valve, while the $1 \text{ M } \Omega$ resistance above it is the grid resistance for the 1st A/F valve. The 100,000 ohm resistance numbered 14 is the anode resistance of the detector valve. The next condenser has a value of $\cdot 001 \mu\text{F}$ and is represented as (C_{21} in fig. 5). The condenser numbered 16 has a value of $\cdot 001 \mu\text{F}$ and is the coupling condenser between the detector and 1st A/F valve. The next condenser has a value of $\cdot 0001 \mu\text{F}$ and is the coupling condenser between the 2nd R/F valve and the detector. The resistance at the top of the group has a value of $\cdot 25 \text{ M } \Omega$ and is the detector grid leak resistance.

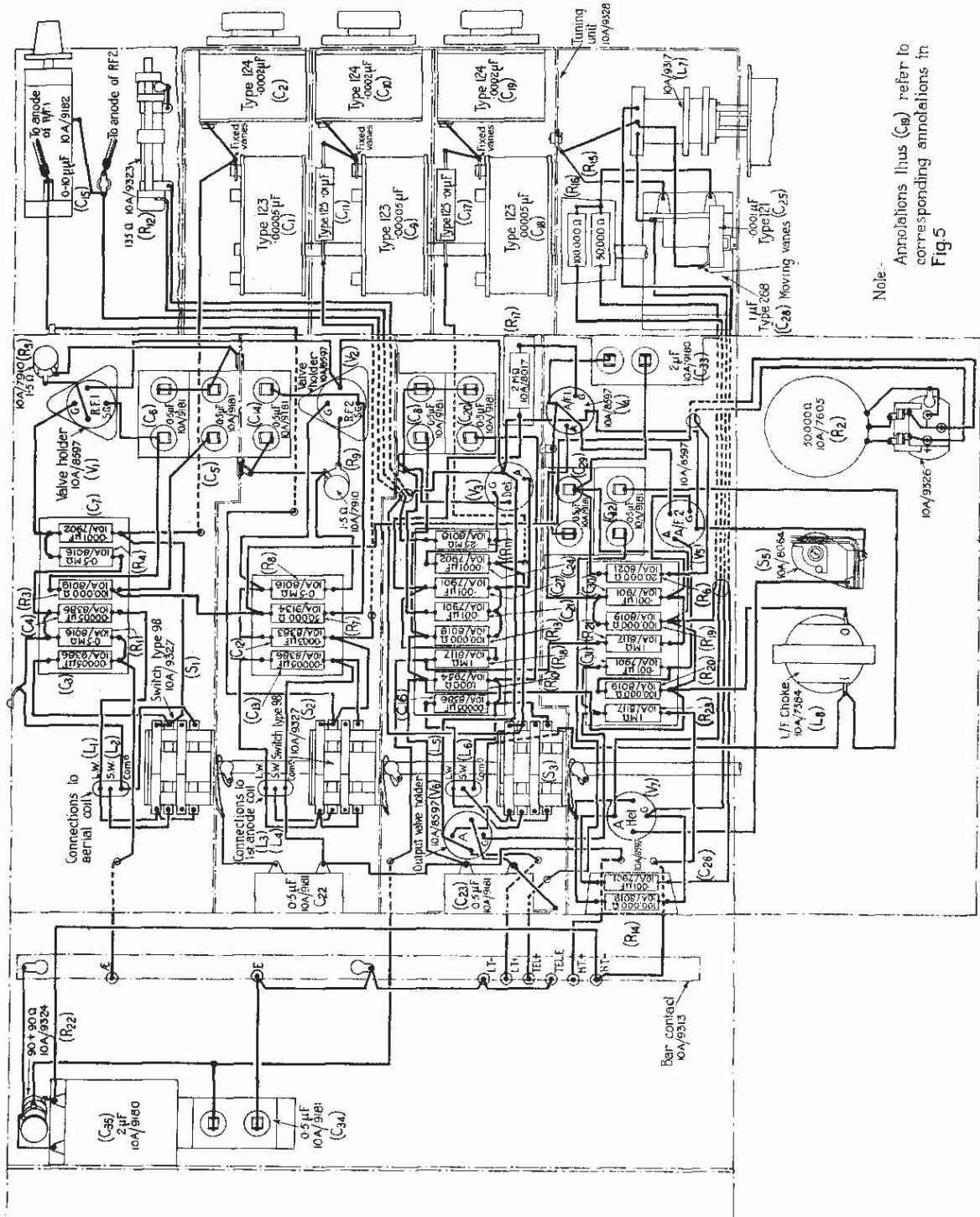
55. The group of components in the last section comprises a $2 \mu\text{F}$ condenser (19), connected between the high potential side of the A/F choke and earth, the 1st and 2nd A/F valve-holders (20) and (21) respectively, two $\cdot 5 \mu\text{F}$ condensers (22), arranged one above the other, the heterodyne filament switch (23), a group of condensers and resistances (24), an A/F choke (25) connected in the anode circuit of the output valve, the heterodyne valve-holder (26) and a unit (27) consisting of a $\cdot 001 \mu\text{F}$ condenser and a 100,000 ohm resistance.

56. Of the two $\cdot 5 \mu\text{F}$ condensers (22), the bottom one is connected between the anode of the output valve and the terminal engraved TEL +, while the upper one is the R/F by-pass condenser (C_{29} , fig. 5). In the condenser and resistance unit (27), the condenser has a value of $\cdot 001 \mu\text{F}$ and is connected as a fixed reaction condenser between the heterodyne inductance and anode. The resistance has a value of 100,000 ohms and is the grid resistance for the heterodyne valve.

57. In the group of condensers and resistances (24) the bottom resistance has a value of $1 \text{ M } \Omega$ and is the grid resistance for the output valve. The next resistance has a value of 100,000 ohms and is the anode resistance for the 2nd A/F valve. The condenser above these two resistances has a value of $\cdot 001 \mu\text{F}$ and is the coupling condenser between the 2nd A/F valve and the output valve. The resistance above it has a value of $1 \text{ M } \Omega$ and is the grid resistance for the 2nd A/F valve. The next resistance has a value of 100,000 ohms and is the anode resistance for the 1st A/F valve. The condenser above this resistance has a value of $\cdot 001 \mu\text{F}$ and is the coupling condenser between the 1st and 2nd A/F valves. The 20,000 ohm resistance above it is connected in the H.T. + lead and is represented by R_6 in the theoretical circuit diagram, fig. 5.

VALVES, GENERATOR AND BATTERIES

58. The transmitter filaments are supplied from four 2-volt accumulators. The H.T. of 1,200 volt is supplied by an 80-watt motor-generator connected to the aeroplane general service



Note - Annotations thus (C₁₉) refer to corresponding annotations in Fig 5

FIG. 20. BENCH WIRING DIAGRAM R1093

battery. The receiver obtains its L.T. current from a 2-volt accumulator, and its H.T. of 120 volts from a dry battery. The valve used in the master-oscillator stage is a V.T.13C valve. The valve used in the amplifier stage is a V.T.25 valve. Of the seven valves used in the receiver, two are type V.R.18, which are screen-grid valves in the R/F stages, and the detector valve is a type V.R.27. Three type V.R.21 valves are used; two in the A/F stages, and one in the heterodyne stage. One type V.R.22 is used in the output stage.

OPERATION

Transmitter

59. Before commencing to tune the transmitter care should be taken to ensure that the compartment cover on the master-oscillator chamber is screwed down tightly and the send-receive switch placed in the "off" position. During the tuning process the key must never be depressed while the selector switch is being operated. The method of tuning is as follows:—

1.2 to 1.5 Mc/s

60. Connect the appropriate aerial. On this range transmission will normally be carried out on a short trailing aerial of stainless steel. The 200-ft. trailing aerial, partially wound out, must not be used for this purpose since the capacitance to earth of the unused portion is too great. For setting up on the ground the fixed aerial is used. The fixed aerial *may* be used on the lower frequency band in the air (see Table 2) with a small loss of performance, and when extreme ranges are not required it may be convenient to do this. The master-oscillator and amplifier range switches should be set to the desired range. It will be observed that this range is split into two bands (on both M/O and amplifier switches), viz., 1.2 to 1.3 and 1.3 to 1.5 Mc/s. The master-oscillator tuning control should now be unlocked and set as nearly as possible to the figures given in the Table. Set the neutralizing condenser to 5.0 and lock it. Set the selector switch to R/T.1.

61. If the send-receive switch is now placed in the "send" position the master-oscillator ammeter should read about one ampere and the milliammeter about 40 to 45 milliamperes. Now unlock the amplifier tuning control and tune this for maximum aerial current, when the milliammeter should read a minimum. The radiated frequency should now be measured by means of wavemeter W.1095. If a note is made as to whether this frequency is above or below that desired, it will facilitate making the correction (up or down) to the tuning of the M/O. Now set the wavemeter to the desired frequency and re-adjust the master-oscillator tuning control, keeping the amplifier in step until the frequency is correct. Lock the controls and set the selector switch for the type of radiation (C.W., I.C.W. or R/T). Since the above adjustments will have been made on the ground with the fixed aerial, a re-adjustment will be required if the short trailing aerial is used in the air. In these circumstances the amplifier must be re-tuned for minimum input. The input and aerial currents for the fixed aerial on the ground will be approximately as follows. For C.W.2, aerial current .9 to 1 amp., and input 65 milliamps. For R/T 2, aerial current .5 to .6 amps., and input 45 milliamps. Slightly higher figures may be expected in the air.

62. Aerial and input currents for the trailing aerial will be approximately as follows. For C.W.2, aerial current .8 to 1.2 amps., and input 75 to 80 milliamps. For R/T 2, aerial current .7 to 1.1 amps., and input 60 milliamps.

2 to 3.4 Mc/s

63. For this band the send-receive switch should be placed in the "off" position as before, and the master-oscillator and amplifier range switches set to the desired range. The appropriate aerial should be connected up. On this range the fixed aerial is used. The master-oscillator should be set as nearly as possible according to figures given in Table 7, and the neutralizing condenser set to about 2.0. The selector switch should now be placed in the "tune" position,

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and if the send-receive switch is now placed in the "send" position, the master-oscillator ammeter should read about 1.5 to 2 amps. (depending upon the frequency) and the milliammeter about 22 milliamps. Now tune the amplifier so as to obtain a maximum fall in the reading of the master-oscillator ammeter, and then increase the setting of the neutralizing condenser until the master-oscillator ammeter reads about 75 per cent. of the maximum obtained prior to the last operation. Next re-tune the amplifier for a minimum in the master-oscillator ammeter, and then make a further adjustment to the setting of the neutralizing condenser to obtain a maximum in the master-oscillator ammeter. This adjustment should be made with great accuracy. The selector switch should now be placed in the R/T.1 position and the amplifier tuned for minimum input, after which the radiated frequency should be measured to ascertain whether it is above or below that required. The wavemeter should now be set to the required frequency and the master-oscillator tuning adjusted until a maximum deflection is obtained on the wavemeter. After making this adjustment the amplifier should, of course, be re-adjusted for minimum input.

Receiver

64. The receiver should be tuned for R/T in the following way. Open the heterodyne filament switch, and place the range switch in the correct position for the range required (1,222 to 1,539 or 2,000 to 3,409 kc/s). Connect a suitable aerial. The volume control should now be set to *maximum*, the ganged fine tuning condensers set to about 110° and the send-receive switch to "receive". Using the trimmers, gang the R/F circuits by obtaining maximum background noise. The trimmers should be used at one end of their range. Next increase reaction until oscillation occurs. Reduce reaction by about two turns of the condenser knob. A wavemeter giving a modulated signal on the frequency required should now be switched on, and the signal searched for on the trimmers, keeping them approximately in step. When the signal is heard, tune in by means of the ganged tuning control. Now move the wavemeter away until the signal is very weak. The reaction should then be re-adjusted by bringing it up to the oscillation point and taking it two turns back. A final adjustment will now be required on the ganged tuning control.

65. The importance of carrying out the tuning operations as described in the preceding paragraph, i.e., with the volume control at maximum and the wavemeter moved away to produce a weak signal, is emphasized. The reason for this is that the tuning of the receiver is affected by the volume control (the R/F valves are impedances connected across the tuned circuits; these impedances are varied by the volume control) and if the receiver is incorrectly set up with the volume control at a low value, when it is subsequently required to receive a weak signal, the volume control will require to be turned up and (although the gain of the receiver will be increased) the receiver will be mistuned and the signal may be missed.

66. For C.W. reception the receiver should first be tuned as above and then the wavemeter switched over to C.W. and the heterodyne switch on the receiver closed. Search for the signal should now be made entirely on the heterodyne control, the reaction being maintained near its minimum value.

PRECAUTIONS AND MAINTENANCE

67. The send-receive switch is situated on the mounting board between the transmitter unit and receiver unit. The moving blades of the switch mesh in one position with spring jaws on the transmitter and in the other position with spring jaws on the receiver. Care must be exercised when removing either transmitter or receiver from the base-board, and in replacing them, to avoid damage to the switch. When removing or replacing the transmitter the switch should be moved into the "receive" position. When removing or replacing the receiver the switch should be put into the "send" position. The master-oscillator valve should be inspected frequently (say every five to ten hours flying, with the filament switched on). If the valve filament is found

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to sag the valve should be discarded. Owing to the comparatively short life of the master-oscillator valve it is important that adequate spares of this valve are available. If no V.T.13 C valve is available, transmission of telegraphy on the higher frequencies is still possible, by allowing the amplifier to self-oscillate. This can be accomplished by setting the neutralizing condenser to either of its extreme positions and choosing the one which gives the better output for a reasonable input. It should be noted that re-adjustment of the tuning will be necessary in these circumstances to regain the desired frequency. In the event of a failure of the V.R.27 valve in the detector stage of the receiver a V.R.21 may be used but the pre-set resistance (9, fig. 17) must be adjusted to suit.

TABLE 1
(Key to Installation Diagram, fig. 21.)

Item No.	Stores Ref.	Nomenclature.	Quantity.	Remarks.
1	10A/9275	Transmitter-receiver T.R.1091		Without valves.
2	10A/9504	Switch unit, type E, complete with plugs and leads.		As wired for Hector aeroplane.
3	5C/430	Block, terminal, type B, 2-way, No. 1 ..	4	
4	10A/7971	Socket, type 29 (combined TEL. MIC) ..	2	
5	10A/7741	Key, morse, type F	2	
6	5A/829	Switch, tumbler, 2-way S.P., No "OFF" position.	1	
7	5A/1362	Cable, L.T., Ducel 4		As required.
8	5A/1358	Cable, L.T., Unicel 4		As required.
9	10A/7439	Socket, type 20 (6 point)	1	
10	10A/7799	Disc, indicating, type M	1	For 10A/7439.
11	10A/8533	Socket, type 42 (4 point)	1	
12	10A/9490	Disc, indicating, type K	1	For 10A/8533.
13	10A/8517	Plug, type 69 (4 point)	1	
14	10A/9489	Disc, indicating, type K	1	For 10A/8517.
15	N.I.V.	Socket, Jacelite, 3 pin, 5-amp.	1	Cat. No. 7170 for 12-V supply.
16	N.I.V.	Plug, Jacelite, 3 pin, 5-amp.	1	Cat. No. 7110 for 12-V supply.
17	10A/8533	Socket, type 42 (4 point)	1	
18	10A/9014	Disc, indicating, type G	1	For 10A/8517.
19	5A/1360	Cable, L.T., Unicel 19		As required.
20	5A/1387	Accumulators, 2-V 20 Ah, type B	5	{ 4 for transmitter. 1 for receiver.
21	N.I.V.	Box, accumulator	1	For 5A/1387.
22	10A/7441	Socket, type 21 (7 point)	1	
23	10A/9488	Disc, indicating, type V	1	For 10A/7441.
24	10A/7437	Socket, type 19 (2 point)	1	
25	10A/8120	Disc, indicating, type E	1	For 10A/7437.
26	10A/7532	Motor, generator, 80-watt, type C	1	
27	10A/9011	Condenser, type 256, 1 μ F	1	Across M.G. H.T. terminals.
28	5A/917	Cable, H.T., uniplug 12, red braided ..		As required.
29	10A/8262	Plug, type 65 (S.P. H.T. —, battery) ..	1	
30	10A/8261	Plug, type 64 (S.P. H.T. +, battery) ..	1	
31	5A/1333 } or 5A/1615 }	Battery, type A, dry, H.T. 120 volts ..	1	Stowed in item 32.
32	N.I.V.	Battery, type B, dry, H.T. 120 volts for overseas use.		
32	N.I.V.	Crate, power	1	For H.T. battery and motor-generator.
33	10A/7997	Starter, type A	1	
34	10A/3387	Terminal, 2 B.A., type A, spring type ..	2	For earth.
35	N.I.V.	Crate, bearers and fittings		
36	10A/9090	Plug, type 72 (S.P.), unispark cable ..	2	
37	10A/4589	Aerial wire, R.4		For fixed aerial.

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TABLE 1—contd.

Item No.	Stores Ref.	Nomenclature.	Quantity.	Remarks.
38	10A/8093	Aerial insulator, type 16 (lead-in)	1	For fixed aerial.
39	5A/82	Cable, H.T., unispark 7, unbraided		For aerial leads.
40	10A/9005	Aerial winch, type 5, frame	1	Complete with earthing lead and socket.
41	10A/9123	Aerial winch, type 5, reel, type B	1	For 10A/9005.
42	10A/7298	Aerial weight, bead, type 1		For trailing aerial.
43	10A/8235	Aerial wire, stainless steel 7/28		
44	10A/8193	Aerial fairlead bush, steel, type 3, flared ..	1	
45	10A/7986	Aerial fairlead bush, insulating	1	
46	N.I.V.	Aerial fairlead clamp	1	
47	10A/7301	Aerial fairlead tube, Dexine, 1 inch	1	For trailing aerial.
48	10A/8531	Socket, type 40 (S.P.)	1	

INSTALLATION

68. An installation diagram is given in fig. 21. It will be seen that, in addition to the aerial and earth leads from the transmitter-receiver, four multi-point plugs are provided. One of these makes the connections to the key, the microphones and the telephones. A second makes the connections for H.T. to the transmitter and receiver and also the I.C.W. switch connections. A third makes the connections for the L.T. to the receiver and transmitter. A fourth provides the connection for starting and stopping the motor-generator, the circuit being closed by a blade on the send-receive switch when the latter is in the "send" position, and opened when in the "receive" or "off" positions. It will be seen that this pair of leads terminates in a two-point plug which is engaged with a two-point socket connected to a Starter, type A.

69. The Starter, type A, is connected to the 12-volt supply through a plug and socket and also to the L.T. terminals of the motor-generator. The starter, which is a device for introducing a resistance in series with the armature and cutting it out at a pre-determined speed, is described in the chapter dealing with transmitter T.1083 in this publication. It will be seen that the three connections, S.R., L.N. and H.N., on the end of the motor-generator are taken through a plug-and-socket connection to the single-pole change-over switch in the bottom left-hand corner of the diagram. The first-mentioned connection (S.R.) is not taken directly to this switch, but is taken through the transmitter in order to bring the interrupter into the H.T. circuit. The I.C.W. note may be selected by means of the switch. The interrupter may of course be short-circuited by the selector switch in the transmitter when C.W. is required. A condenser type 256 is connected across the H.T. leads of the motor-generator.

70. A 4-point jack is provided for each occupant of the aeroplane, one pair of contacts of each jack being wired in parallel to a socket engraved MIC, TEL, KEY, which engages with the corresponding plug on the transmitter. The other pair of contacts are wired in parallel to the telephone connections on the same socket. The 4-way cord connected to the telephones and microphone worn by each occupant terminates in a 4-way plug. When this plug is inserted into the above-mentioned jack, the microphone is connected to the microphone transformer in the transmitter, and the appropriate telephones connected in the output circuit of the receiver or the side-tone circuit of the transmitter, depending upon the position of the send-receive switch. Thus, during transmission, any one of the occupants by speaking into his microphone, may transmit R/T and hear side-tone. During reception the microphone circuit is broken and all the phones are connected in the output circuit of the receiver. A plug-and-socket connection enables either the fixed or the trailing aerial to be used.

Fixed wiring shown thus:—
Removable wiring shown thus:—
For key see table 1.

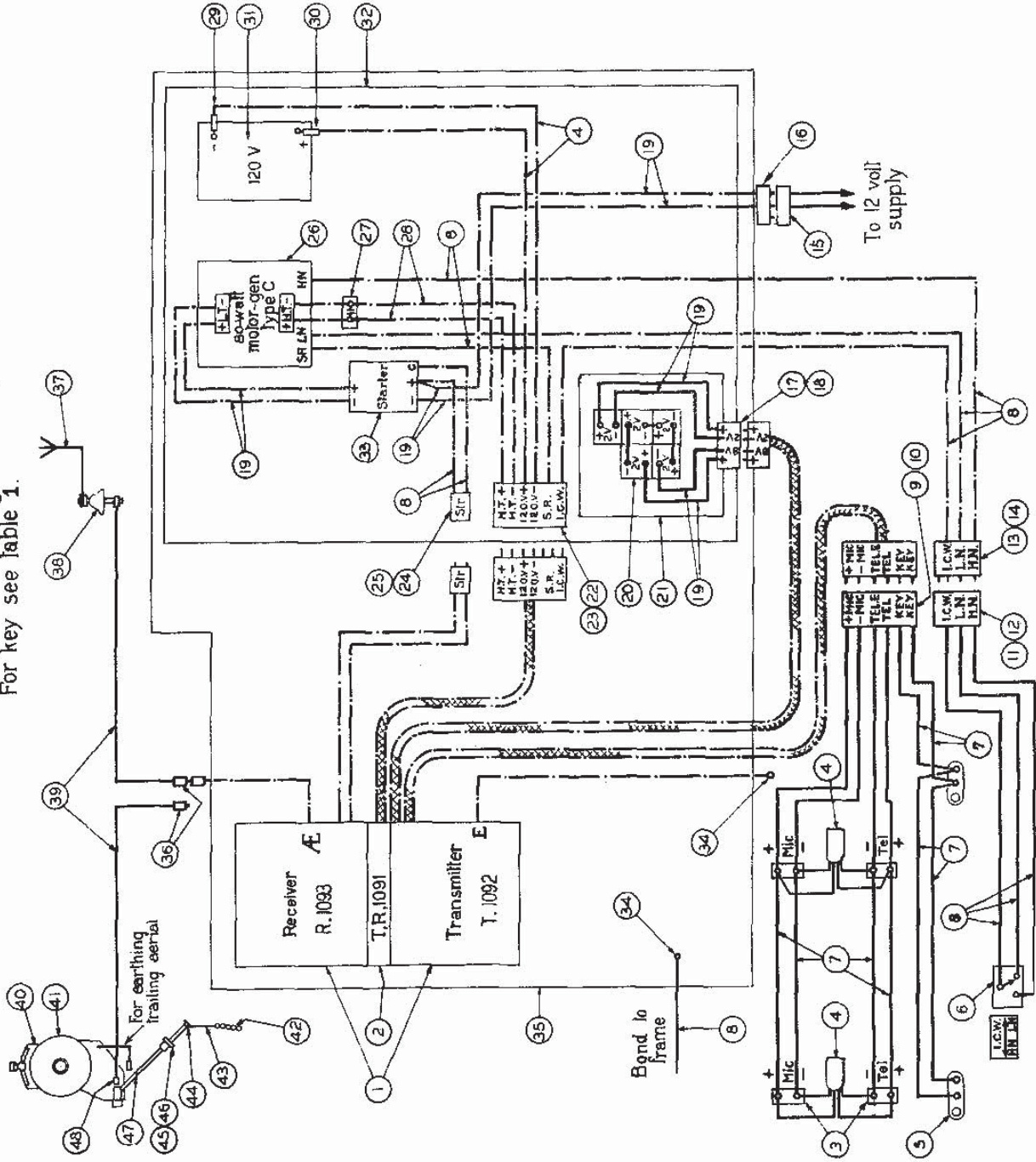


FIG. 21. INSTALLATION DIAGRAM. T.R.1091 (HECTOR)

TABLE 2

Aerial System : Broad Arrow. Calibrated on the Ground. 1,222 to 1,364 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,205	9-5	8-3	6-0	64	1.0	45	0.5
1,222	8-5	7-7	6-0	64	1.0	45	0.5
1,240	7-5	6-9	6-0	64	1.0	45	0.6
1,265	6-5	6-0	6-0	64	1.0	45	0.6
1,290	5-5	5-2	6-0	64	1.0	45	0.6
1,328	4-5	4-6	6-0	64	1.0	45	0.6
1,354	3-5	3-7	6-0	64	1.0	45	0.6
1,372	2-5	3-0	6-0	64	1.0	45	0.6

TABLE 3

Aerial System : 20 ft. trailing. 1,222 to 1,364 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,205	9-5	9-0	5-0	80	0.8	60	0.7
1,222	8-5	8-0	5-0	80	0.9	60	0.8
1,240	7-5	7-4	5-0	75	0.9	60	0.8
1,265	6-5	6-2	5-0	80	1.0	60	0.8
1,297	5-5	5-6	5-0	80	1.0	60	0.8
1,328	4-5	5-2	5-0	80	1.0	60	0.9
1,354	3-5	4-6	5-0	80	1.0	60	0.9
1,372	2-5	4-0	5-0	80	1.0	60	1.0

TABLE 4

Aerial System : Broad Arrow. 1,364 to 1,539 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,353	10-5	10-2	6-0	64	1.0	45	0.5
1,367	9-5	9-6	6-0	64	0.9	45	0.5
1,383	8-5	8-8	6-0	64	0.9	45	0.5
1,413	7-5	8-0	6-0	64	0.9	45	0.5
1,447	6-5	7-1	6-0	64	0.9	45	0.5
1,482	5-5	6-4	6-0	64	0.9	45	0.5
1,515	4-5	5-8	6-0	64	0.9	45	0.5
1,545	3-5	5-0	6-0	64	0.9	45	0.5
1,570	2-5	4-9	6-0	64	1.0	45	0.5
1,600	0-0	4-7	6-0	64	1.0	45	0.5

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TABLE 5

Aerial System : 20 ft. trailing. 1,364 to 1,539 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,353	10-5	12-3	5-0	80	1.1	60	1.0
1,367	9-5	10-5	5-0	80	1.1	60	1.0
1,383	8-5	9-6	5-0	80	1.2	60	1.1
1,413	7-5	8-8	5-0	80	1.2	60	1.1
1,447	6-5	8-0	5-0	80	1.2	60	1.0
1,482	5-5	7-2	5-0	75	1.1	60	1.0
1,515	4-5	6-3	5-0	70	1.1	60	1.0
1,545	3-5	5-6	5-0	70	1.0	60	0.9
1,570	2-5	5-2	5-0	70	1.0	60	0.9
1,600	0-0	4-6	5-0	70	1.0	60	0.9

TABLE 6

Aerial System : Broad Arrow. Calibrated on the Ground. 2.0 to 2.5 Mc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,910	14-180	22-20	6-8	62	1.3	46	0.9
1,990	13-180	20-100	6-8	62	1.3	46	0.9
2,070	12-180	18-150	6-8	62	1.3	46	0.9
2,160	11-180	16-200	6-9	62	1.4	46	0.9
2,190	10-180	15-200	6-9	62	1.4	46	0.9
2,240	9-180	14-200	6-9	62	1.4	46	0.9
2,310	8-180	13-220	6-9	62	1.4	46	0.9
2,380	7-180	12-240	6-7	60	1.4	46	1.0
2,460	6-180	11-250	6-7	60	1.4	46	1.0
2,500	5-180	10-290	6-7	60	1.4	46	1.0

TABLE 7

Aerial System : Broad Arrow. Calibrated on the Ground. 2.5 to 3.4 Mc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
2,500	12-180	18-340	6-1	62	1.7	46	1.1
2,540	11-180	17-320	6-1	62	1.7	46	1.1
2,580	10-180	16-290	6-1	62	1.7	46	1.1
2,650	9-180	15-220	6-1	60	1.7	46	1.1
2,700	8-180	14-200	6-1	60	1.7	46	1.1
2,750	7-180	13-140	6-1	60	1.7	46	1.1
2,885	6-180	12-100	5-7	60	1.7	46	1.2
2,940	5-180	11-60	5-7	60	1.7	46	1.2
3,000	4-180	10-40	5-7	60	1.7	46	1.2
3,120	3-180	9-20	5-8	60	1.7	46	1.2
3,260	2-180	7-340	5-8	60	1.7	46	1.2
3,330	1-180	6-300	5-8	60	1.6	46	1.1
3,400	0-340	6-80	5-8	60	1.6	46	1.0

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9275	Transmitter-receiver T.R. 1091, consisting of :—		Complete without switch unit.
10A/9276	Board, mounting	1	Fitted with four mountings, anti-vibration, type 3, and 4 feet, ball, Ref. Nos. 10A/9277 and 10A/9278 respectively.
10A/9280	Transmitter, type T.1092	1	Complete without valves.
10A/9279	Receiver, type R.1093.. .. .	1	Complete without valves.
	<i>Transmitter T.1092.</i>		
	Principal components :—		
	Ammeter, thermo,		
10A/8480	0 to 3·0, type B	1	
10A/8038	0 to 2·5, type A	1	
10A/9284	Bar, contact	1	Fitted with 11 contacts.
	Choke, H/F		
10A/9285	Type 31	1	
10A/9286	Type 32	1	
10A/9287	Type 33	1	
	Coil		
	Amplifier		
10A/9288	3,409 to 2,000 kc/s	1	Variable, with counting mechanism.
10A/9289	1,539 to 1,222 kc/s	1	With variometer coil.
	Master-Oscillator		
10A/9290	3,409 to 2,000 kc/s	1	Variable with counting mechanism.
10A/9291	1,539 to 1,222 kc/s	1	With variometer coil.
	Condenser		
10A/8044	Type 139	1	·01 μ F.
10A/8048	Type 143	1	·001 μ F.
10A/8496	Type 188	1	·01 μ F.
10A/9292	Type 269	1	·000025 μ F.
10A/9293	Type 270	1	·002 μ F.
10A/9294	Type 271	1	·0005 μ F.
10A/9295	Type 272	1	·000065 μ F.
10A/9296	Type 273	1	·00018 μ F.
10A/9297	Type 274	1	·002 μ F.
10A/9298	Type 275	1	·00006 μ F.
10A/9299	Type 276	2	·002 μ F.
10A/9300	Type 277	1	0·5 μ F.
10A/9301	Type 278	1	·000065 μ F.
10A/9374	Type 298	1	·0004 μ F.
	Drive		
10A/9302	Slow motion	1	With lock
10A/9303	Slow motion	1	Without lock.
10A/3412	Holder, valve, V.T.13	2	
10A/9304	Milliammeter, 0 to 40 and 0 to 120.. .. .	1	Double scale.
	Resistance		
10A/9305	Type 243	1	1·3 ohms.
10A/9306	Type 244	2	30,000 ohms, 1·5-watt, rod type.
10A/9307	Type 245	1	5,000 ohms.
10A/9308	Type 246	1	5,000 ohms.
10A/9309	Type 247	1	5,000 ohms, slab wound.
	Switch		
10A/9310	Type 99	1	Barrel type, multi-contact.

SECTION 2, CHAPTER 3

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter receiver T.R. 1091— <i>contd.</i> Transmitter T.1092— <i>contd.</i> Principal components— <i>contd.</i> Switch— <i>contd.</i>		
10A/9311	Type 100	1	Barrel type, multi-contact.
10A/9312	Type 101	1	Barrel type, multi-contact.
10A/8539	Transformer, microphone Type H	1	
	Receiver R.1093. Principal components:—		
10A/9313	Bar, contact	1	Fitted with 8 contacts.
10A/7384	Choke, L/F Type B	1	
10A/9314	Coil, L.W.	3	Dust-iron core aerial, 1st and 2nd anode.
10A/9315	Coil, S.W.	3	Aerial, 1st and 2nd anode.
10A/9317	Coil, heterodyne	1	Variable dust-iron core.
	Condenser		
10A/7901	Type 120	5	·001 μ F.
10A/7902	Type 121	2	·0001 μ F.
10A/8383	Type 173	1	·0003 μ F.
10A/8386	Type 176	4	·00005 μ F.
10A/9180	Type 281	2	2·0 μ F.
10A/9181	Type 282	10	0·4 μ F.
10A/9182	Type 283	1	Miniature variable, with screw adjustment.
	Cover		
10A/9321	Bottom	1	
10A/9322	Top	1	
	Holder, valve		
10A/8597	Type L	7	
	Resistance		
10A/7910	Type 97	2	1·5 ohms
10A/7954	Type 101	1	1,000 ohms, $\frac{1}{2}$ -watt, rod type.
10A/8016	Type 108	3	·5 M Ω , $\frac{1}{2}$ -watt, rod type.
10A/8017	Type 109	1	2 M Ω , $\frac{1}{2}$ -watt, rod type.
10A/8018	Type 110	1	0·25 M Ω , $\frac{1}{2}$ -watt, rod type.
10A/8019	Type 111	5	100,000 ohms, $\frac{1}{2}$ -watt, rod type.
10A/8021	Type 113	1	20,000 ohms, $\frac{1}{2}$ -watt, rod type.
10A/8117	Type 123	3	1 M Ω , $\frac{1}{2}$ -watt, rod type.
10A/9323	Type 240	1	135 ohms, variable.
10A/9324	Type 241	1	180 ohms, centre tapped.
10A/9134	Type 231	1	50,000 ohms, $\frac{1}{2}$ -watt, rod type.
10A/7605	Type 75		50,000 ohms, variable potentiometer.
	or		
10A/9505	Type 253	1	50,000 ohms, variable potentiometer.
	or		
10A/9506	Type 254		50,000 ohms, variable potentiometer.
	Socket		
10A/9326	Type 46	1	3 pole, with plug operated switch contacts.
	Switch		
10A/8064	Type 70	1	Single pole "on-off" rotary type with gold-silver contacts.
10A/9327	Type 98	3	Barrel type, with four pairs spring contacts.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter-receiver T.R.1091— <i>contd.</i>		
	Receiver R.1093— <i>contd.</i>		
	Principal components— <i>contd.</i>		
10A/9328	Units tuning	1	Fitted with :— 1 condenser, type 266, .001 μ F. 3 condensers, type 123, .0005 μ F. 3 condensers, type 124, .0002 μ F. 2 condensers, type 125, .01 μ F. 1 condenser, type 268, 1.0 μ F. 1 resistance, type 111, 100,000 ohms. 1 resistance, type 231, 50,000 ohms.
	Accessories.		
	Transmitter-receiver, T.R.1091 :—		
10A/9281	Case, transit	1	
10A/9282	Switch, unit, type E	1	Without plugs and leads.
	Unwired		
	Switch unit		
	Wired for :—		
10A/9502	Anson aeroplane		With the appropriate plugs and leads connected for each installation.
10A/9785	Demon aeroplane		
10A/9504	Hector aeroplane		
10A/9747	A.39/34 Westland aeroplane		
	Transmitter T.1092.		
	Accessories :—		
	Valve		
10A/7510	Type V.T.13C	1	
10A/7312	Type V.T.25	1	
	Receiver R.1093		
	Accessories :—		
	Valve		
10A/7607	Type V.R.18	2	For R/F stages.
10A/7738	Type V.R.21	3	For A/F and heterodyne.
10A/9851	Type V.R.22	1	For output stage.
10A/8239	Type V.R.27	1	For detector.
	Accessories Installation		
	Controls, remote, comprising :—		Typical for Hector aeroplane, see installation diagram, fig. 21.
10A/8189	Casing, flexible, type C		Quantity as required.
10A/8190	Casing, rigid, type C		Quantity as required.
10A/8585	Cleat, type C		For securing casing, rigid to aeroplane structure.
10A/8186	Controller	1	
1B/4178	Gun lubricator, type B	1	For use with 10A/9119.
10A/8195	Handle, condenser unit	1	
10A/9515	Pin, key, type C		For use with unions, casing, type B.
10A/9508	Plug, type 77 (3 pin)	1	Cable, L.T. triflexmet, 2.5, metal braided (8 ft.) to be demanded under 5A/1423.
10A/8192	Shafting, flexible, type C		Quantity as required.
10A/8746	Switch, coupling, type E		For "send-receive".
5C/432	Terminal block, type B	1	3-way.
10A/8193	Union, casing, type B		Quantity as required.
10A/9119	Union, lubricating, type C		Quantity as required.

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TRANSMITTER-RECEIVER T.R.9.D.

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TRANSMITTER-RECEIVER TYPE T.R.9D

(Stores Ref. 10D/10470)

INTRODUCTION

1. The transmitter-receiver T.R.9D is designed for use in aeroplanes to provide two-way air-to-ground or air-to-air R/T communication with a higher degree of frequency stability than is obtainable in earlier instruments. It consists of the transmitter T.1119 and the receiver R.1120 fitted into a single case. The H.T. supply for both transmitter and receiver is provided by a single 120-volt dry battery housed in a tray forming a portion of the case. Filament heating supply for both transmitter and receiver is provided by an external 2-volt accumulator.

2. The transmitter-receiver is designed to operate over a frequency range of approximately 4.3 to 6.6 Mc/s, the radiated frequency being stabilized by means of a quartz crystal. Two such crystals are incorporated in the transmitter so that either of two predetermined frequencies may be transmitted. Of these one only is used for ordinary R/T communication; this is referred to as the "normal," and the other, on which an unmodulated carrier only is radiated, as the "special" frequency. The range of the R/T communication from air to ground is at least 35 miles, and from air to air at least five miles. In normal circumstances these ranges are usually exceeded.

3. The instrument is primarily intended for use in single-seater fighter aeroplanes, and provision is made for its operation by means of a system of remote controls. When fitted in a single-seater aeroplane, the microphone is disconnected from its transformer when the SEND-RECEIVE switch is in the RECEIVE position. When fitted in a two-seater or multi-seater aeroplane, however, provision may be made for inter-communication between certain members of the crew, using the audio-frequency stage of the receiver as an I/C amplifier. The I/C circuit is operative even if transmission of R/T is actually taking place. This provision is made for tactical purposes which need not be discussed here. During transmission of the "special" frequency, however, the I/C circuit is inoperative.

4. The overall dimensions of the transmitter-receiver, in its case, are approximately 19½ in. by 13½ in. by 9½ in. The weight excluding batteries, is approximately 28 lb. With valves and dry batteries in place, the weight is about 40 lb. The total weight of the complete installation is further increased to about 67 lb. by the mechanical remote control system for transmitter operation and receiver tuning, and the electrical control system for shifting the frequency from "normal" to "special." The general appearance of the transmitter-receiver is shown in fig. 7.

GENERAL DESCRIPTION

5. The transmitter T.1119 consists of a crystal-controlled oscillator driving an anode-modulated class C radio-frequency power amplifier.

6. Provision is made for the employment of either of two types of microphone, namely, the carbon capsule type which has hitherto been generally used with service transmitters, or alternatively, a recently developed electro-magnetic microphone. The advantage of the latter lies in its greater approach to linear operation and consequent reduction of inter-modulation (see A.P.1093, Signal Manual, Part II, Chapter XII). It is however much less sensitive than the carbon microphone, and the audio-frequency stages of the receiver R.1120 are therefore employed to amplify the voice-frequency output of the microphone transformer before application to the input terminals of the modulator valve. When performing the latter function this portion of the receiver is treated as a single unit of the transmitter and referred to as the sub-modulator stage.

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7. The action of the transmitter will be described with reference to the complete circuit diagram, fig. 2, but the principal features will be more easily understood with the aid of the simplified theoretical diagram, fig. 1. The same notation is employed in both diagrams. The frequency-shifting switches S_1, S_2, S_3, S_4 , are, actually, the contacts of a pair of relays, S_1, S_2 , being embodied in one relay and S_3, S_4 , in the other. These switches are operated simultaneously, since the operating windings are connected in parallel. When the windings are de-energized the contacts are in the normal position and the "normal" frequency is radiated. The windings are energized by a current from the L.T. battery when it is desired to radiate the "special" frequency. The relay operating circuit is closed by a special switching device which is called the remote contactor. The operation of this contactor is dealt with later.

8. Two of the four poles of the SEND-RECEIVE switch enter into the operation of the frequency shifting arrangements, and only these two are included in fig. 1. It will be seen that the pole SR_1 nominally changes over the positive H.T. supply from transmitter to receiver, but the pole SR_2 is connected in such a manner, that, if the SEND-RECEIVE switch is at RECEIVE and the relay operating circuit is completed, the switch S_2 will close an alternative path by which the transmitter receives a H.T. supply, and the "special" frequency is radiated. When the switch S_2 is in the "special" position, the H.T. supply to the sub-modulator stage is interrupted, so that the "special" frequency is invariably unmodulated.

Crystal-controlled oscillator

9. Referring to figs. 1 and 2, it will be seen that the oscillator stage of the transmitter consists of the valve V_1 , which receives its H.T. supply through the R/F choke L_2 , while the grid bias is maintained at the desired value by the grid condenser C_1 and leak resistance R_1 . The frequency of the oscillation is entirely governed by a pre-selected quartz crystal, two of which are fitted, one for the "normal" and one for the "special" frequency. Depending upon the position of the switch S_1 oscillations will always be maintained at one or other of these frequencies, unless the SEND-RECEIVE switch is in the OFF or RECEIVE position. Even if the SEND-RECEIVE switch is at RECEIVE, however, the special frequency is still radiated, whenever the relay windings are energized. No tuned circuit is provided in the master oscillator stage but, in conjunction with the valve inter-electrode capacitance (including that of the crystal and its self-capacitance), the choke L_2 functions as a very flatly-tuned rejector circuit over the whole frequency band covered by the transmitter. The oscillator stage is coupled to the power amplifier stage by the fixed condenser C_2 .

R/F power amplifier

10. The power amplifier valve V_2 is a pentode and no neutralization arrangements are necessary to prevent R/F instability. The control grid is maintained at a suitable mean negative potential by the leak resistance R_2 . The anode load impedance consists of the aerial tuning inductance L_3 , the aerial capacitance, and any other capacitance which may be in parallel therewith. A fixed anode tap is provided for the whole frequency range. The valve obtains its H.T. supply by the series feed system *via* the R/F choke L_4 and the iron-cored speech choke L_5 . The screening grid is maintained at a convenient mean positive potential (slightly below that of the anode) with respect to the filament, by the screen feed resistance R_3 . The latter is shunted by an audio-frequency by-pass condenser C_4 . The R/F potential of the screening grid is maintained at a low level by the radio-frequency by-pass condenser C_3 , while the condenser C_5 is the oscillator mains condenser of the power amplifier stage.

11. Two variable aerial tapping points are provided, the selection being made by the switch S_3 . In the "normal" position, the aerial tuning is achieved by a helically-driven rotating contact arm as in the transmitter T.R.9B. In the "special" position, the aerial is connected to any one turn of the aerial coil by means of a sliding contact on the outside of the coil. This contact is moved from turn to turn by a helical thread operated by a suitable control on the front of the panel, fine tuning being effected by the variable condenser C_6 . The latter is brought into

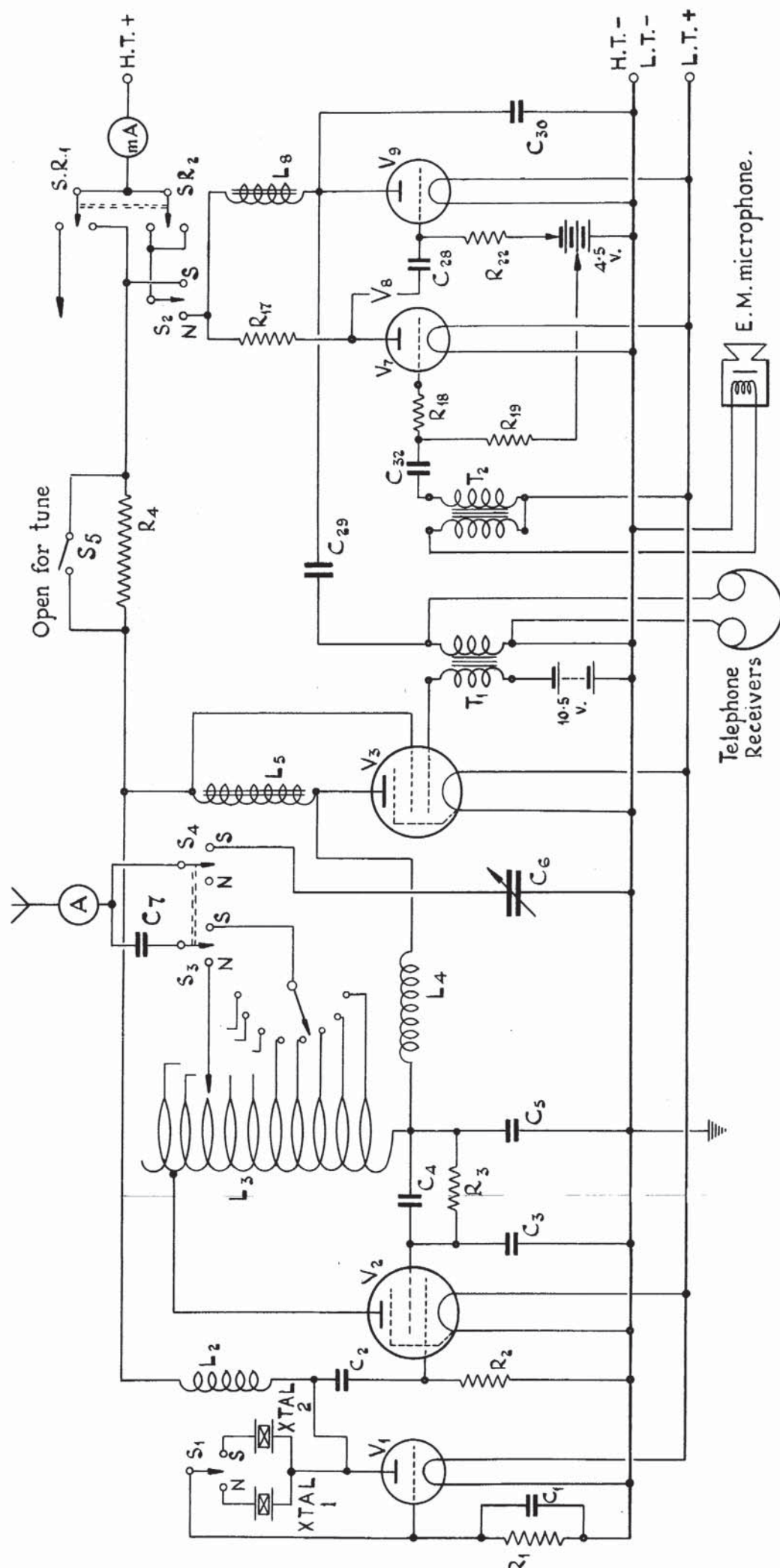


FIG.1. SIMPLIFIED CIRCUIT DIAGRAM (TRANSMITTING)

CONDENSERS	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30
RESISTANCES	R1	R2	R3	R4					R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22				
INDUCTANCES																														
MISCELLANEOUS	V1	S2	S1	REL1	V3	V2	S3	S4	REL2	SR2	SR3	SR4																		

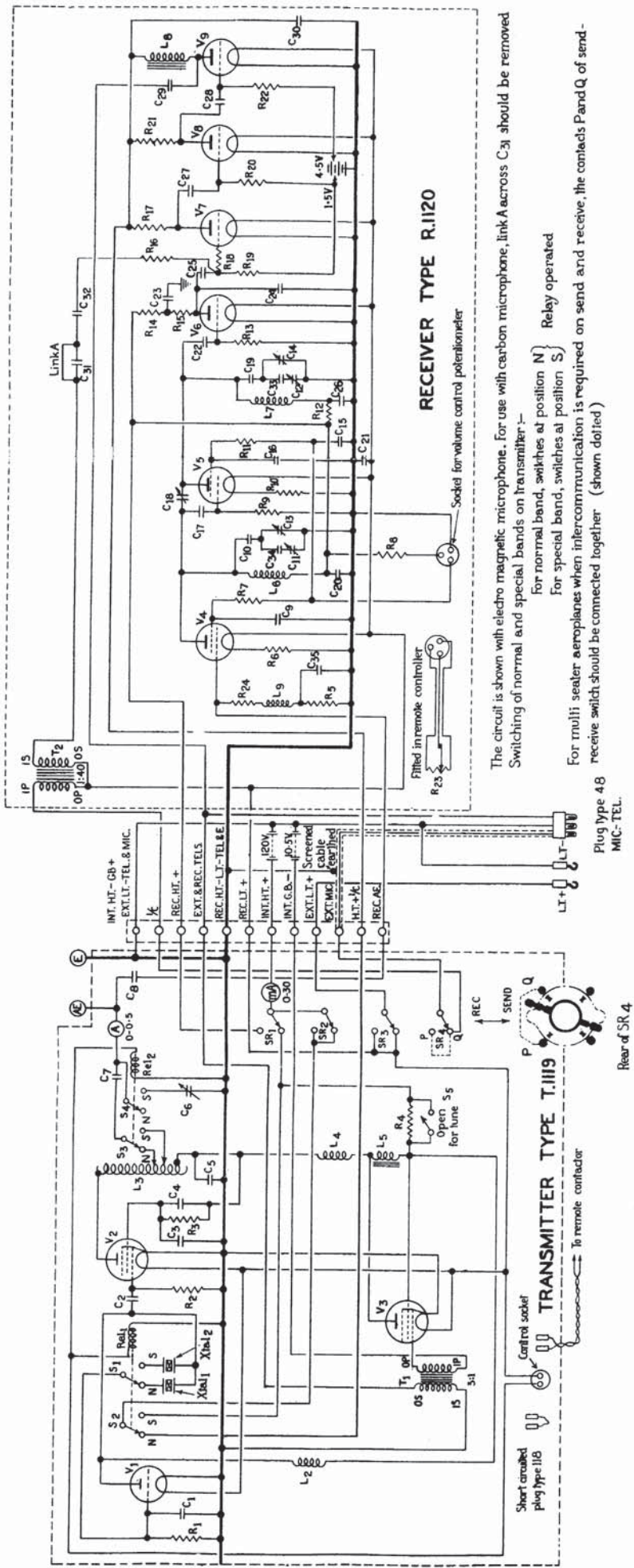


FIG. 2 T.R.9D. THEORETICAL CIRCUIT DIAGRAM

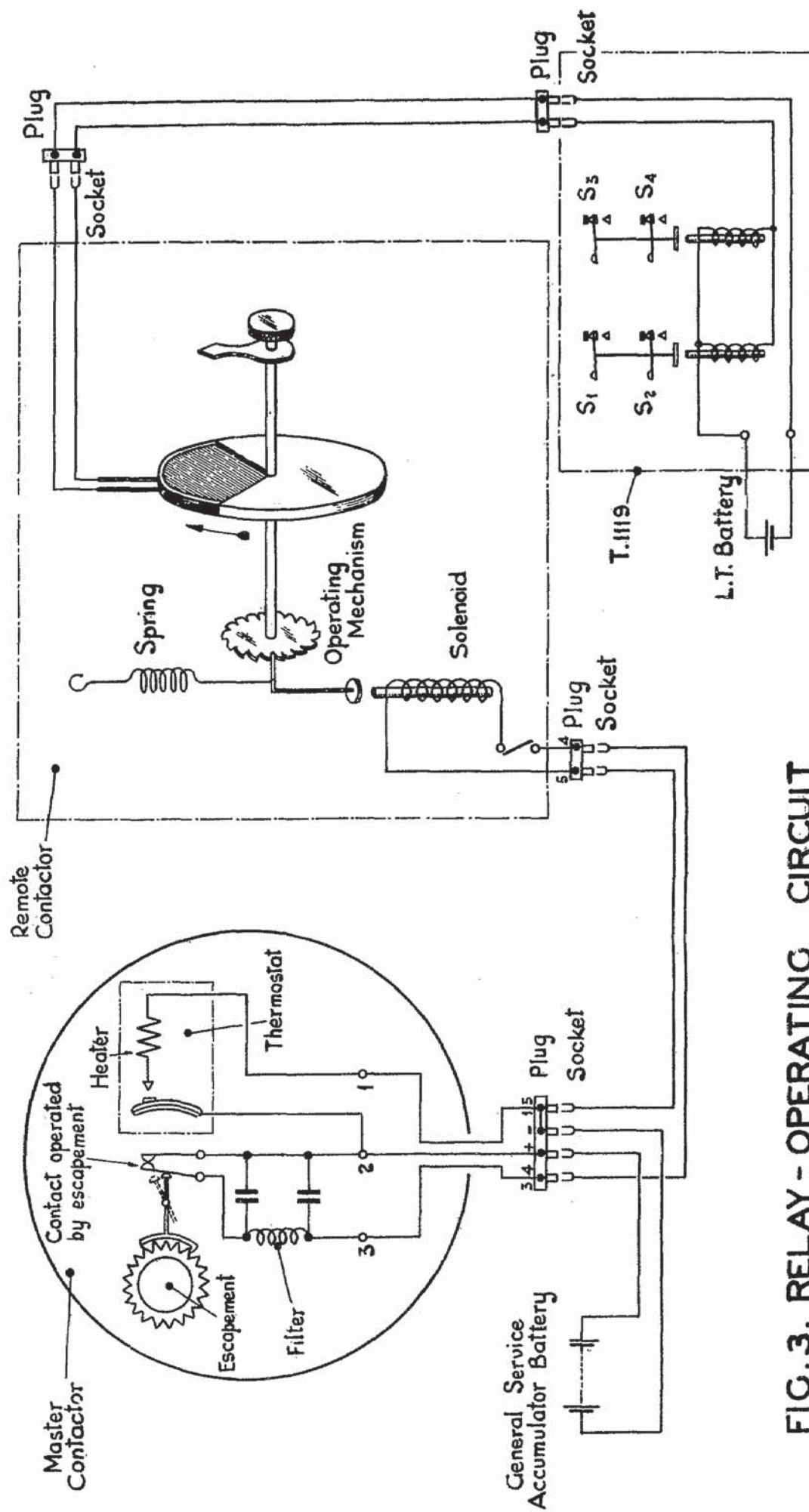


FIG. 3. RELAY - OPERATING CIRCUIT

circuit by the switch S_4 . By this method, the tuning of the "special" frequency is achieved without disturbing the tuning of the "normal" frequency. The remainder of the aerial circuit is comprised by the isolating condenser C_7 and aerial ammeter A.

Modulator

12. A pentode is also employed as the modulator valve V_3 . The valve obtains its H.T. supply *via* the speech choke L_5 which is also included in the H.T. circuit of the power amplifier valve. The screening grid of the modulator valve is maintained at a constant positive potential, practically equal to the mean anode voltage. The audio-frequency control-grid excitation is derived from the sub-modulator stage. On speaking into the microphone, audio-frequency voltages are applied by the secondary winding of the transformer T_2 between grid and filament of the valve V_7 , which is resistance-capacitance coupled to a valve V_8 (not shown in fig. 1). This valve is coupled in the same way to the audio-frequency power amplifier valve V_9 . The anode circuit of this valve contains the iron-cored feed choke L_8 , and the load impedance is coupled to the valve by the blocking condenser C_{29} . The load impedance consists of the primary winding of the transformer T_1 , with the telephones in parallel therewith. The secondary winding of the transformer is connected between control grid and filament of the modulator valve, and supplies the latter with the required voice-frequency excitation.

Sub-modulator stage

13. The necessity for the inclusion of this stage has already been explained, but it must be realized that the group of three valves, V_7 , V_8 , V_9 , may perform three different functions, namely, an audio-frequency amplifier for normal R/T reception, a sub-modulator stage during transmission, and an inter-communication amplifier where necessary. For the latter purpose, the output A/F voltage must be of the order of 15 volts R.M.S. whereas the grid-filament P.D. required by the modulator valve in order to modulate the carrier to a depth of about 90 per cent., is only about 5 volts. The transformer T_1 therefore has a step down ratio of 3 to 1.

14. Owing to the high gain of the sub-modulator, the wiring of the electro-magnetic microphone must be completely screened, otherwise audio-frequency self-oscillation may occur. In fig. 2, the screening of the internal wiring of the microphone circuit has been indicated, and this screening must be extended to the extension of this lead as a part of the aircraft wiring, and also to the leads of the microphone itself (*see* installation diagram, fig. 18). It will be noted that the winding of the electro-magnetic microphone carries a direct current from the L.T. battery. Although this current is not necessary for its correct performance, this provision permits the substitution of a carbon microphone without any alteration in the wiring of the primary circuit.

15. It is important to note that if a carbon microphone is employed, it is necessary to open the link A which normally short-circuits the condenser C_{31} (fig. 2 only). This condenser is very small compared with C_{32} , with which it is then in series, and the voice-frequency grid-filament voltage of the valve V_7 is correspondingly reduced. The position of this condenser is indicated in fig. 12 and para. 54 dealing with the constructional details.

Switching clock

16. The frequency-shifting relays are operated by means of an automatic switching system, the principal components of which are the master contactor and remote contactor. The operation of this system will be described with reference to fig. 3, which is a theoretical diagram of the operating circuit, and does not purport to show the mechanical detail other than in principle. The installation diagram, fig. 18, should also be referred to. The electrical supply for the switching clock is derived from the general service accumulator battery, which may be either twelve or twenty-four volts.

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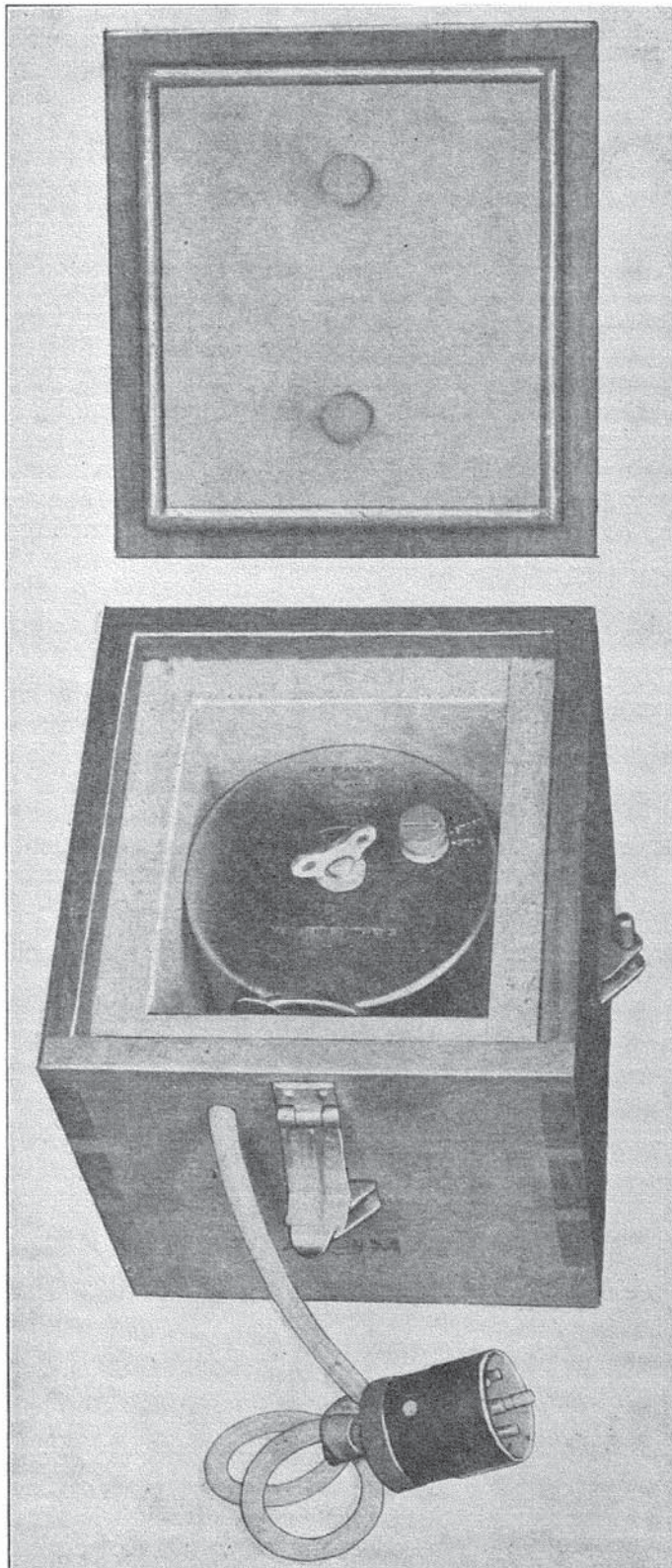


FIG. 4. MASTER CONTACTOR IN CASE.

17. The master contactor, which is shown in figs. 4 and 5, consists of a spring-driven clock, the escapement of which beats twice per second. Each vibration of the escapement closes an electrical contact, which in turn transmits an electrical impulse to the remote contactor. The latter thus receives electrical impulses at a regular rate of 120 impulses per minute. The case of the master contactor contains a thermostatically-controlled heating coil, which serves to maintain its interior at a constant temperature irrespective of weather conditions and altitude. An electrical filter circuit of special design is fitted in the base of the contactor in order to minimize interference with radio reception. As a further precaution, the wiring of the switching system is maintained as far away as possible from the telephone and microphone wiring. The master contactor is fitted in a wooden box lined with sponge rubber, and is mounted in the crate by means of a suitable suspension.

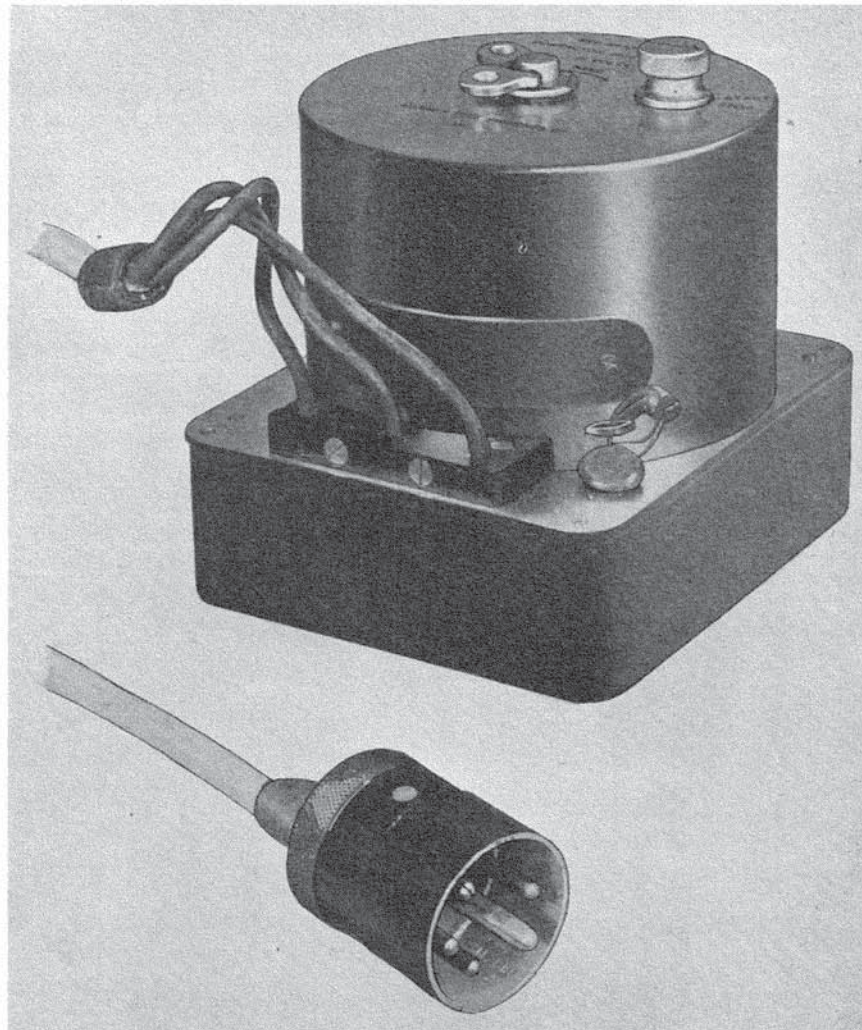


FIG. 5. MASTER CONTACTOR

18. The remote contactor, shown in fig. 6, incorporates a special form of step-by-step motor, the rotor of which performs one revolution per minute. During 14 seconds of each minute, the rotor causes the closure of an electrical contact and consequent completion of any electrical circuit connected thereto. This circuit is, in the present installation, the 2-volt circuit which includes the operating coils of the frequency-shifting relays.

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19. The operation of the remote contactor will be further described with reference to fig. 6 which shows the face of the instrument. The rotor spindle carries a pointer (1) rotating over the dial at a speed of one revolution per minute. On the dial, four lines (2), (3), (4) and (5) are boldly engraved at 0° , 90° , 180° and 270° respectively, and the sector between 0° and 90° is

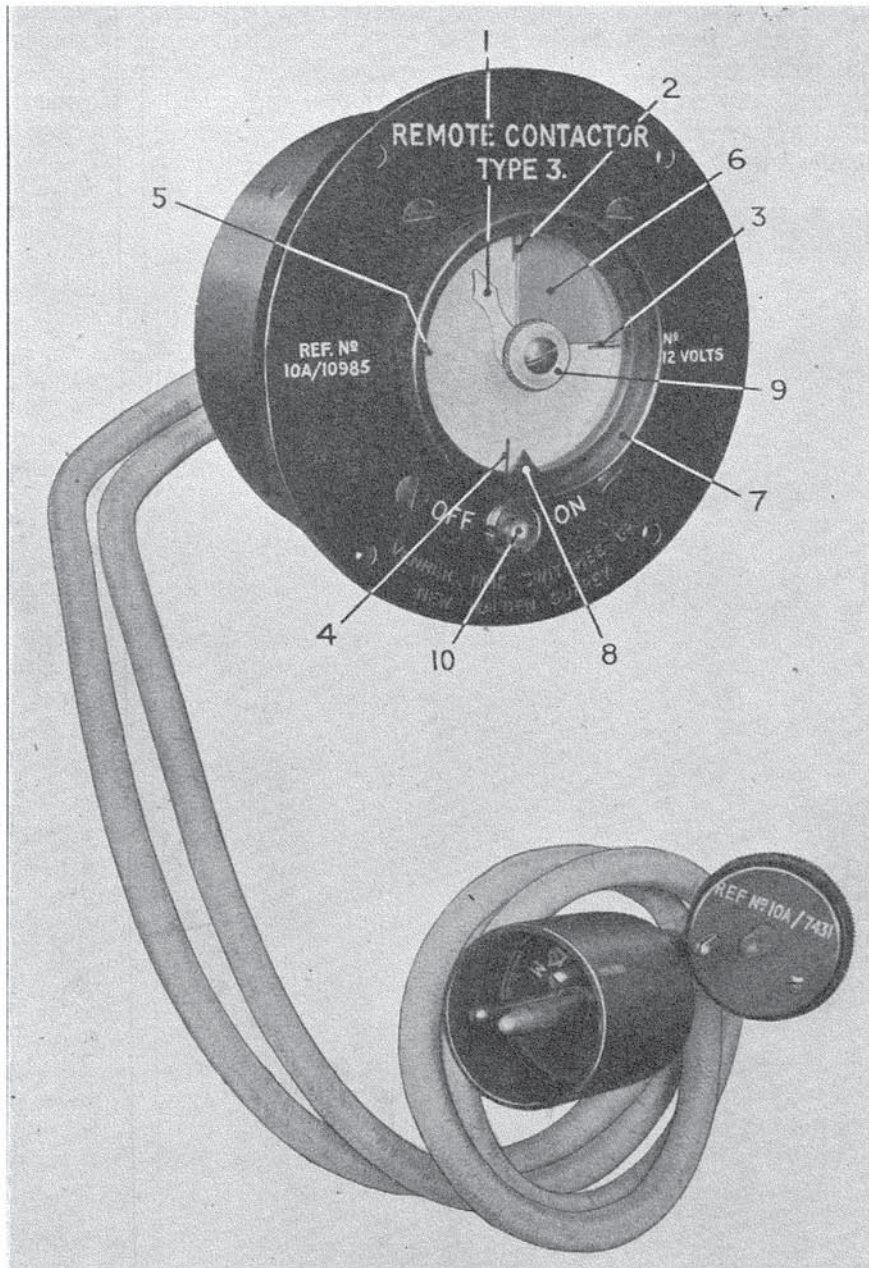


FIG. 6. REMOTE CONTACTOR.

coloured red. External to the front glass cover is an adjustable rubber ring (7) carrying a triangular index (8). The ring may be rotated, and is invariably adjusted to such a position that the index coincides with one of the four lines engraved on the dial. The rotating pointer is beneath the glass cover, but its spindle is extended through the latter and terminates in a milled knob (9),

by which the pointer may be set in any desired position relative to the coloured sector. The internal contacts are closed during the time the pointer is traversing the coloured sector.

20. A tumbler switch (10) is fitted beneath the dial, the face plate being engraved to show the ON and OFF positions. This switch completes the circuit from the master contactor to the motor of the remote contactor, and its closure sets the rotor in motion, carrying the pointer with it. Thus, if the tumbler switch is OFF and the adjustable index is set to 270° , the pointer being aligned with it, the following sequence of operations will occur when the tumbler switch is moved to ON. First, the pointer will traverse the sector 270° to 0° ; during this interval of 15 seconds the external circuit is open. On reaching 0° the external circuit is closed and remains so for 14 seconds, i.e. while the pointer traverses the red sector. During the next 46 seconds while the pointer moves from 84° to 360° , the external circuit will remain open. The red sector is then traversed again, during which time the external circuit is closed, and so on.

21. Now suppose that in a second installation the tumbler switch is in the OFF position the adjustable index set to 180° , and the pointer aligned with it. On closing the switch, the pointer traverses the sector 0° to 180° in the first 30 seconds, during which time the external circuit is open. On reaching 0° the external circuit is closed and remains so for 14 seconds, followed by an open-circuit period of 46 seconds and so on. It follows that if the remote contactors in the two installations are both started at the same instant, the external circuit of the second contactor will be closed one second after the external circuit of the first is opened. In a third installation, the initial position of the pointer may be 90° , and in a fourth, 0° . If these four installations are started simultaneously each will transmit its special frequency for 14 seconds in each minute, and the respective transmissions will follow each other with a one-second interval between each.

Receiver

22. The receiver circuit will be discussed with reference to fig. 2. Six valves are employed: the first two, V_4 , V_5 , are radio-frequency amplifying tetrodes, followed by a detector valve V_6 , two audio-frequency amplifying valves V_7 , V_8 , and a power amplifier valve V_9 . The aerial circuit of the transmitter forms the aerial circuit of the receiver also. This is permissible since in practice two-way R/T communication takes place only on the particular "normal" frequency allotted to any aeroplane or formation. The aerial is connected to the grid of the valve V_4 *via* the coupling condenser C_8 . A radio-frequency choke L_9 , resistance R_{24} , and a resistance R_5 with the condenser C_{35} in parallel, are connected in series between grid and filament.

23. The anode circuits of the valves V_4 , V_5 , are of similar design. In effect, the well known tuned-anode-capacitance coupling is employed. The tuned circuit between the valves V_4 and V_5 consists of the tuning inductance L_6 , with which are associated the condensers C_{10} , C_{11} , C_{13} , C_{34} . Similarly the tuned circuit between the valves V_5 , V_6 consists of the tuning inductance L_7 and the condensers C_{19} , C_{12} , C_{14} , C_{33} . The fine tuning condensers C_{11} , C_{12} , are ganged together and operated, either remotely or locally, by a single control. The moving vanes of all the variable condensers are in metallic connection with the case of the receiver in order to prevent the effect of body capacitance, and it is therefore necessary to complete the "tuned anode" circuits by means of blocking condensers C_{10} , C_{19} . A radio-frequency decoupling condenser C_{20} is fitted between the low potential end of the inductance L_6 and the L.T.—line, while the anode circuit of the valve V_5 is decoupled from that of the valve V_4 by a resistance R_{12} and condenser C_{26} .

24. The fixed condensers C_{34} , C_{33} serve to reduce the frequency cover of the fine tuning condensers C_{11} , C_{12} . With these condensers short-circuited, this would be of the order of 200 kc/s on the lower and 1 Mc/s on the higher frequencies; with these condensers in circuit however the corresponding figures are 40 kc/s and 200 kc/s approximately. A small permanent control-grid bias is provided for each of the radio-frequency amplifying valves by the insertion of resistances R_6 , R_{10} in series with their respective L.T.—leads.

25. The screening grids of the valves V_4 , V_5 are fed from the H.T.—line *via* the resistances R_7 , R_{11} . The condensers C_9 , C_{16} , maintain the oscillatory potential of the respective screening grids (with respect to L.T.—) at a very low amplitude. The main feed resistance R_8 is con-

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nected directly to the H.T.+ line, and to the centre point of a three-point socket. One of the outer points of this socket is connected to L.T.— and the other to the screen feed resistances R_7 , R_{11} . Variation of the screening-grid voltage, for the purpose of volume control, is accomplished by connecting an external potentiometer R_{23} to this socket by means of a three-point plug. The condenser C_{15} is connected between the variable tapping on the potentiometer and the L.T.— line.

26. The anode circuit of the valve V_4 is coupled to the control grid of the valve V_5 by the condenser C_{17} . A variable condenser C_{18} is connected between the anode of the valve V_4 and the anode of the valve V_5 . This condenser acts as a control of the regenerative amplification. The mean grid potential of the valve V_5 is maintained at the desired value by the grid leak resistance R_9 . The anode circuit of the valve V_5 is coupled to the control grid of the detector valve V_6 by the condenser C_{22} , a grid leak resistance R_{13} being also fitted. Its anode circuit includes the load resistance R_{15} and radio-frequency by-pass condenser C_{24} , the latter serving to maintain the input conductance of this valve at a low value. A decoupling resistance R_{14} and decoupling condenser C_{23} are also fitted. The anode load circuit is coupled to the first audio-frequency amplifying valve V_7 by the grid condenser C_{25} , the grid leak resistance R_{19} being connected to the —1.5 volt tapping on the grid bias battery. A grid stopper resistance R_{18} is interposed between the grid condenser and the control grid of the valve in order to reduce the amplitude of the radio-frequency grid swing. The by-pass condenser C_{24} also contributes to this reduction.

27. The secondary winding of the microphone transformer forms an alternative means of providing a grid-filament excitation for this valve, for the purpose of transmitter modulation and inter-communication where the latter is required. The secondary winding of the transformer is connected in series with the two condensers C_{31} , C_{32} , the former being short-circuited by the link A when an electro-magnetic microphone is used. A resistance R_{16} is also included in this circuit. It will be seen that this arrangement, in effect, prevents the transformer secondary from acting as a low impedance shunt upon the output of the preceding valve V_6 during R/T reception, but does not seriously attenuate the voice-frequency voltages during I/C and modulation. When a carbon microphone is in use, a much greater degree of attenuation is deliberately introduced by the insertion of the condenser C_{31} .

28. The anode circuit of the valve V_7 is coupled to the control grid of the valve V_8 by the condenser C_{27} , a grid leak resistance R_{20} being included. This resistance is also connected to the —1.5 volt tapping on the grid bias battery. The valves V_8 and V_9 are coupled exactly as are the valves V_7 and V_8 , the grid bias for the valve V_9 being —4.5 volts. The anode circuit of the latter valve includes the iron-cored choke L_8 , the coupling condenser C_{29} , and the primary winding of the modulator input transformer T_1 . The telephone receivers are connected in parallel with this winding, through the right-hand and centre pins of the three-point plug, type 48. The anode circuit is thus of the "choke-filter output" type.

29. The microphone is connected to the primary winding of the microphone transformer *via* the contact EXT/MIC on the contact bar, and the contact Q (figs. 2 and 8) on the rear disc of the SEND-RECEIVE switch, when the latter is at SEND. When this switch is at RECEIVE, however, the microphone is disconnected. The transmitter is always supplied with the connections arranged in this manner. Where it is necessary to provide for I/C to be available when the S.R. switch is at RECEIVE, the service units concerned are responsible that the contacts P and Q are connected by a short link of copper wire, as indicated by a dotted line on an inset diagram in fig. 2. The inset diagram shows the third disc from the panel, viewed from the rear.

H.T. and L.T. supplies

30. Referring to fig. 2 it will be seen that the centre point of the plug, type 48, is in direct connection with the negative L.T. lead, the negative H.T. lead, the transmitter grid bias positive lead, and earth. When the SEND-RECEIVE switch is at either the SEND or RECEIVE positions, the filament circuits, both of transmitter and receiver, are completed by the pole SR_3 . When the SEND-RECEIVE switch is at RECEIVE, the R/F and detector valves of the receiver obtain a H.T. supply *via* the terminal REC. H.T.+ on the contact bar, but the audio-frequency valves are supplied, *via* the switch S_2 and the contact bar terminal H.T.+ I/C, only when S_2 is in the "normal" position.

CONSTRUCTIONAL DETAILS

Transmitter

31. The transmitter T.1119 and receiver R.1120 are both contained in the same case, as shown in fig. 7, the transmitter being on the left. The principal components of the transmitter unit are mounted on the under side of a metal panel. The meters and controls are mounted on the face of this panel and can be seen in fig. 7. At the upper left-hand corner is the H.T. milliammeter (mA) which has a range of 0—30 milliamperes. Adjacent to it is the aerial ammeter (A), which is a thermo-couple instrument reading 0—0.5 amperes; the thermo-couple is fitted inside

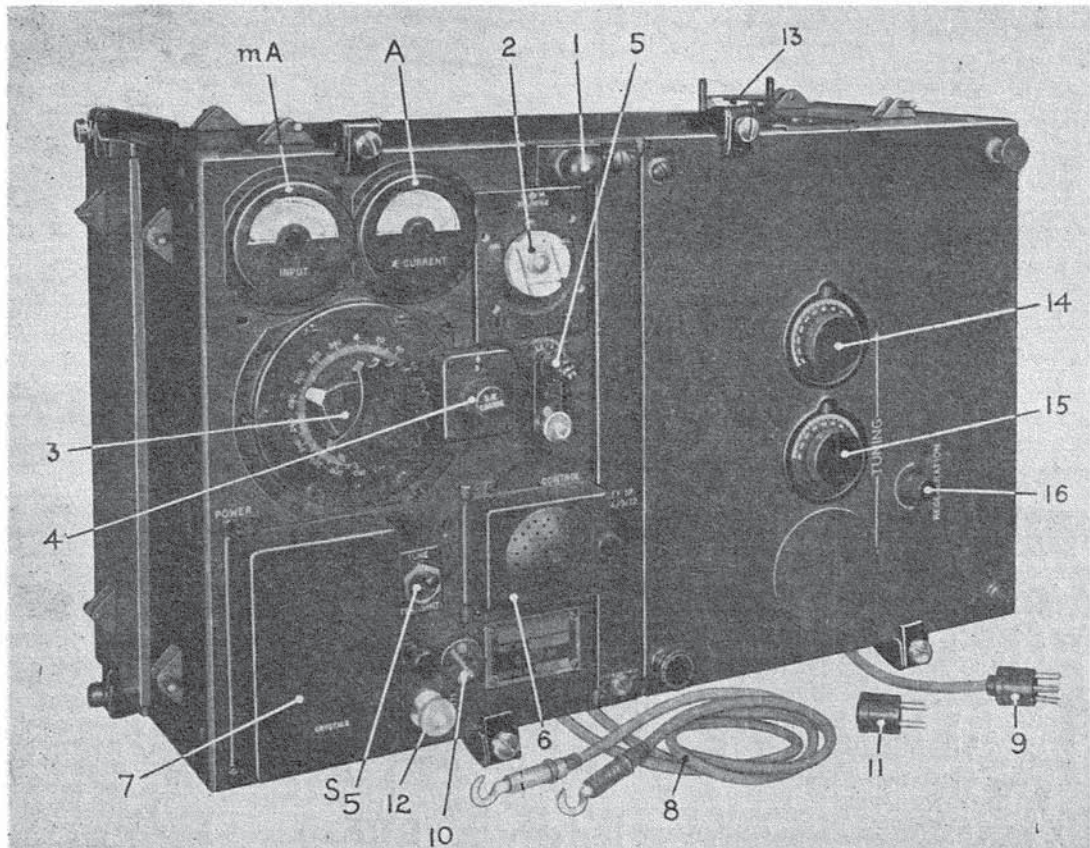


FIG. 7. TRANSMITTER-RECEIVER T.R.9D.

the case of the instrument. Both these meters are fitted with a fixed protective cover over the lower half of the dial, and a rotating cover which can be turned to cover the upper half of the dial when required. The latter operation also exposes the zero adjuster. In the top right-hand corner is the aerial terminal (1). Below this is a slotted switch head (2) which controls the SEND-RECEIVE switch. This slotted head engages with the remote control coupling, and the latter also carries a lever for the local operation of the switch.

32. Immediately below the current meters is the aerial coil. The handle (3) controls a helical spindle mounted along the axis of the coil, by which a moving contact is carried round the turns of the coil. This forms the aerial tuning device for the normal frequency. Each revolution of the handle moves the contact through a complete turn, and the number of turns in circuit is shown by a number displayed in a small window in the zero position of the graduated scale. The latter is marked in degrees, and the setting of this inductance is expressed by a number representing the number of complete turns, followed by the reading of the pointer on the graduated scale, thus, 5,120 represents 5 turns plus 120 degrees.

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33. To the right of the "normal" tuning control is another control (4) marked S.AE COARSE. This control rotates a helical spindle, the axis of which is parallel to that of the coil. The rotation of this control causes a sliding brush contact to move from turn to turn of the coil. The number of complete turns in circuit is shown by a number displayed in a window, as in the case of the "normal" tuning control.

34. On the extreme right of the panel is the control head (5) of the fine tuning condenser for the "special" frequency. It is engraved S.AE FINE and carries a rotating disc engraved with an arbitrary scale reading from 0 to 9, with unmarked intermediate lines. In conjunction with a line engraved on the panel, this scale serves to record the fine tuning adjustment for the special frequency. The control is fitted with a locking device of the usual service "scissors" pattern.

35. Below the three aerial tuning controls are two hinged doors. That on the right (6) gives access to the modulator valve, and is marked CONTROL. The larger one on the left (7) gives access to the power amplifier valve, and also to the crystal holders.

36. Between the two doors is a tumbler switch (S_5) the face plate of which is marked TUNE and TRANSMIT. In the latter position this switch short-circuits the limiting resistance in the H.T.+ supply to the modulator and amplifier valves. When the switch is at TUNE this resistance is in circuit.

37. The L.T. battery leads are shown at (8), while (9), is a plug, type 48, serving to connect the external telephones and microphone or microphones. One of the two leads entering this plug is the microphone + lead and is screened by metal braiding, while the other is a twin cable consisting of the telephone + lead and the common microphone and telephone lead. All these leads are enclosed in a woven sleeve. The extension of these connections is shown on the installation diagram, fig. 18.

38. Just below the right-hand door is the socket (10) by which the remote contactor is connected to the transmitter. This socket, although assembled as part of the panel, is in effect a socket type 11. The remote contactor, or dummy contactor as the case may be, is connected to this socket by means of a plug, type 34. For tuning purposes on the ground, a short-circuited plug, type 118, (11) is supplied. In order that this plug may be readily identified, its top is painted red. A special stowage place is provided for it in the transit case. Aerial and earth terminals are provided, the former (1) being at the top and the latter (12) at the bottom of the panel.

39. Figs. 8 and 9 give two views of the interior of the instrument and fig. 10 is a bench wiring diagram. Referring to figs. 8 and 9 the milliammeter (mA) and the thermo-ammeter (A) are mounted on the front panel, and adjacent to the latter is the SEND-RECEIVE switch (S.R.). The latter is assembled in three units, each of which consists of a fixed ring of insulating material carrying a number of fixed contacts. The centre of each ring is filled by a rotatable disc, also of insulating material, carrying moving contacts. This disc is rotated through 90° in passing from SEND to RECEIVE, by means of a flat bar which is operated by the externally slotted head of the SEND-RECEIVE switch. The function of the outer of the three units is to complete the circuit through the microphone and microphone transformer, when the SEND-RECEIVE switch is to SEND. If I/C is desired when the SEND-RECEIVE switch is to RECEIVE, as may be the case in multi-seater aeroplanes, the soldering tags P and Q, shown in an inset diagram in fig. 2, must be connected by a short lead of tinned copper wire. The connection must be made by careful soldering, taking particular care not to destroy the electrical efficiency of the existing connection at Q, and that the added connection does not touch any material other than the tags to which it is soldered.

40. One of the two frequency-shifting relays is shown at (1). This is mounted on the side of the case and not on the panel. This relay operates contacts corresponding to the switches S_3 and S_4 in figs. 1 and 2. Below and a little to the left of the SEND-RECEIVE switch is the fine tuning condenser (C_6) for the "special" frequency, its control extending through the panel as shown in the previous diagram. Below it is the speech choke (L_5) (choke L/F. type G).

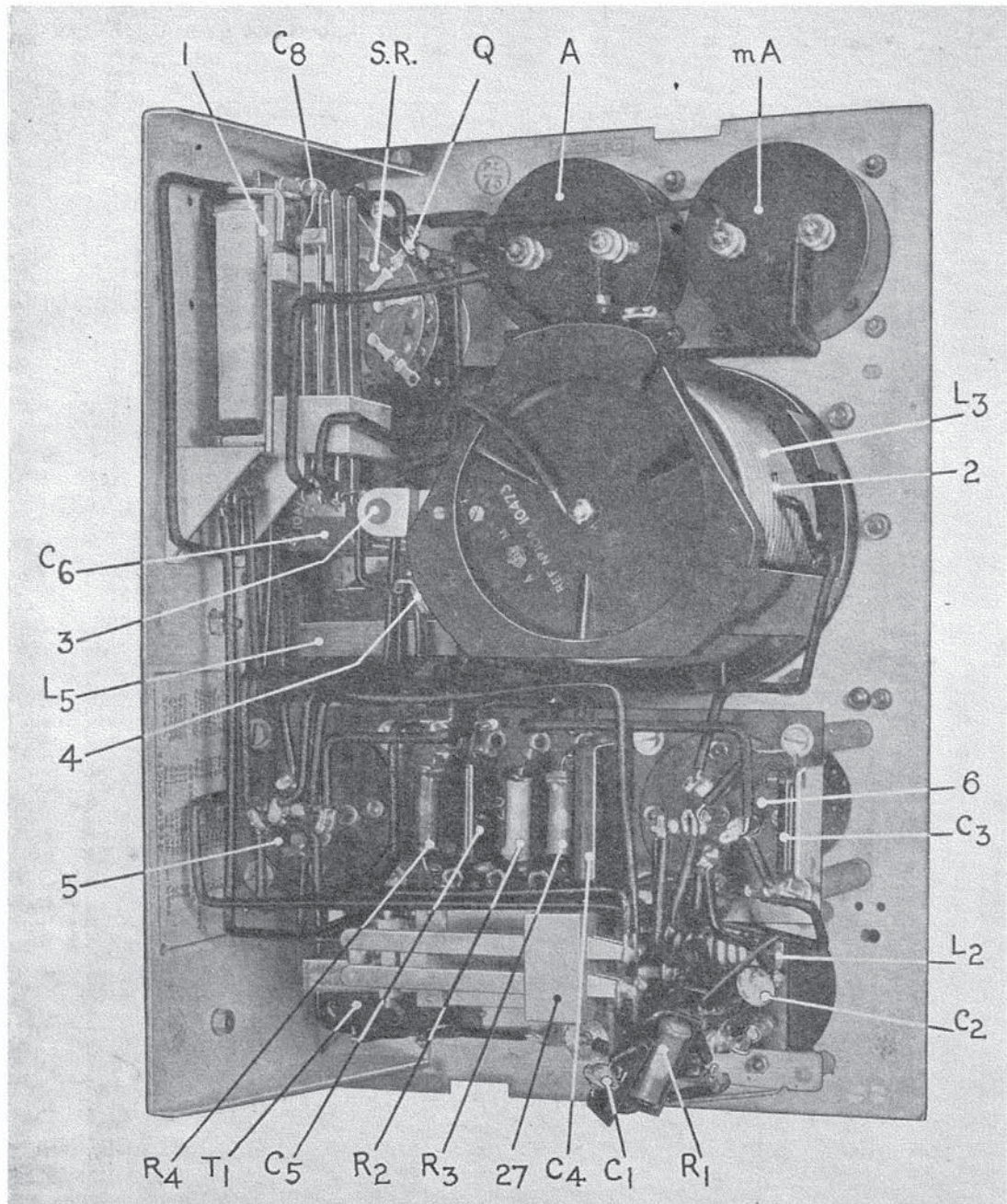


FIG. 8. TRANSMITTER T.1119, REAR VIEW.

41. The right-hand centre portion of the interior is occupied by the aerial coil (L_3), which consists of 16 turns of silver-plated copper tubing. The anode tap (2) is fixed, $10\frac{1}{2}$ turns being included between the feeding end of the coil and the tap. Two tuning taps are provided. The first, for the "normal" aerial tuning, consists of a radial arm with a split contact embracing the tubing. This arm is carried round the turns by the action of a screw thread, cut in a shaft, which is mounted in bearings upon the axis of the coil. This shaft is actuated by the control N.AE TUNING. The other tuning tap is actuated by the control marked S.AE COARSE. The same

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principle is adopted as in the former instance. The inner end of the threaded shaft is carried by the bearing (3). Its rotation carries one end of a flat spring contact from turn to turn; the other end of this contact bears on a contact bar (4) to which the external connection is made.

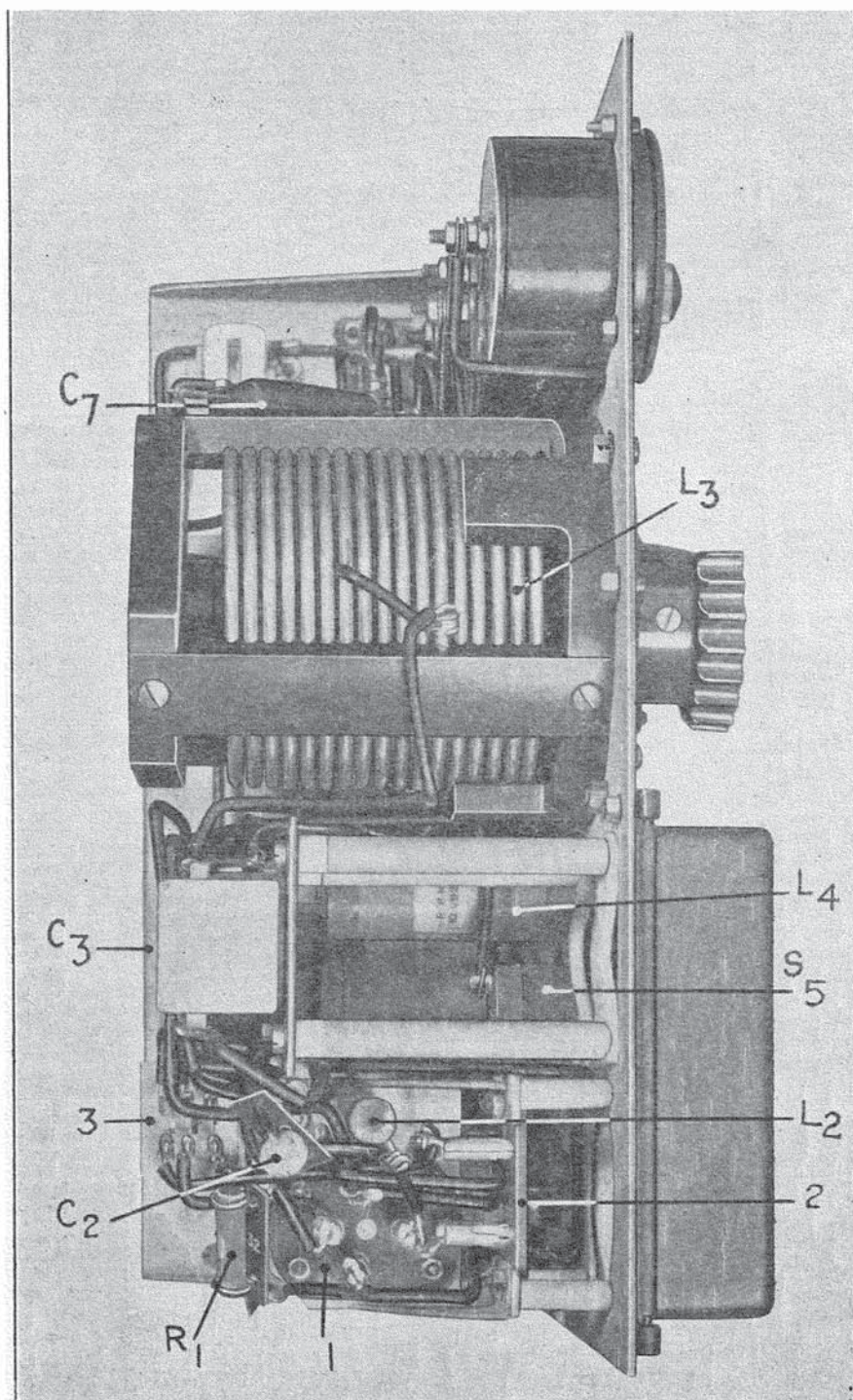


FIG. 9. TRANSMITTER T.1119, SIDE VIEW.

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The accurate register of the flat spring, with regard to any particular turn, is maintained by a serrated disc in which a flat spring engages, locking the moving contact in any desired position. Adjacent to the speech choke is a R/F choke, type 34 (L_4 , fig. 9 only), which is connected in series with the H.T. supply to the amplifier valve.

42. Below the components already mentioned is a platform of insulating material which carries two valve-holders (5) and (6) for the modulator (control) and amplifier (power) valves respectively. The valves face towards the panel and are accessible through doors in the latter. On the outer side of this platform is mounted a group of condensers and resistances. These components will be dealt with in order from left to right. On the extreme left (R_4) is a resistance of 5,000 ohms which is connected in series with the H.T. supply to the modulator and amplifier valves and may be short-circuited when necessary by the "tune-transmit" switch (S_5 , fig. 9). Next to it is the oscillatory mains conductor (C_5). Adjacent to the latter is the grid leak resistance (R_2) for the power amplifier valve. The two components on the right of the shelf are the screen feed resistance (R_3) with its by-pass condenser (C_4). Mounted very near to the right-hand valve-holder (6) is the screen by-pass condenser (C_3).

43. Below the platform is the input transformer (T_1) of the modulator valve, the "tune transmit" switch (S_5) and the R/F choke (L_4) for the amplifier valve. The two latter components can be seen in fig. 9 only. The small coupling condenser (C_2) by which the oscillator is coupled to the amplifier valves is shown in both photographs. The oscillator grid condenser (C_1) and leak resistance (R_1) are mounted near the valve-holder for the oscillator valve (see 1, fig. 9). Adjacent thereto are the two crystal holders (2), in which the required crystals may be inserted by opening the door marked POWER. The second relay (3) operating the switches S_1 , S_2 , of figs. 1 and 2, is mounted in front of these components. The R/F choke (L_2) for the oscillator valve is mounted immediately above the oscillator valve-holder. The condenser (C_8 , fig. 8) which couples the aerial to the receiver is situated near to the SEND-RECEIVE switch. The aerial blocking condenser (C_7) is mounted on the upper side of the framework of the aerial coil, and is clearly shown in fig. 9.

Receiver

44. The receiver R.1120 is fitted into the right-hand side of the case as shown in fig. 7, in which (13) is the main tuning control (17) and (18), the pre-set tuning controls and (16) the regeneration control. A view of the upper side of the receiver, with the cover removed, is given in fig. 11. Nearly all the components are mounted upon a metal panel, some above and some below. Above the panel, the screening box (1) contains three compartments, of which only two are used. These contain the two main tuning condensers (C_{13} and C_{14} , fig. 2), the control knobs (2) and (3) of which are brought out through the top of the box, and also the two fine tuning condensers C_{11} , C_{12} , which are ganged together and operated by a single control head. The two fixed band-reducing condensers (C_{34} and C_{33} , fig. 2) are mounted adjacent to their respective fine tuning condensers. In addition, the condenser C_{19} of fig. 2, which acts as an isolating capacitance in the second tuned-anode circuit, is also mounted in this box.

45. A small sub-panel (4) carries the socket, type 17 (5), by which the external volume-control potentiometer is connected to the receiver, and also the control head for fine tuning. A 2μ F condenser (C_{30}) which acts as a mains condenser for the sub-modulator stage, is also housed behind this sub-panel, while the grid bias battery is carried in a spring clip (6) by the side of the bracket which supports the sub-panel.

46. Five of the six valves are grouped on one side of the screening box, the output valve and the two anode circuit tuning inductances (in their screening covers) being arranged on the opposite side. The six valves are mounted on the upper side of the panel. The functions of the various valves are marked on the panel adjacent to the respective valve-holders. The two R/F valves are screened from each other by a metal partition. The regeneration control condenser (C_{18}) is mounted on the side of the screening box, and has a control knob which projects through the cover as shown in fig. 7. The top anode connectors (7), (8), for the first and second R/F valves are connected in circuit by short leads of flexible cable. The detector valve and the two A/F

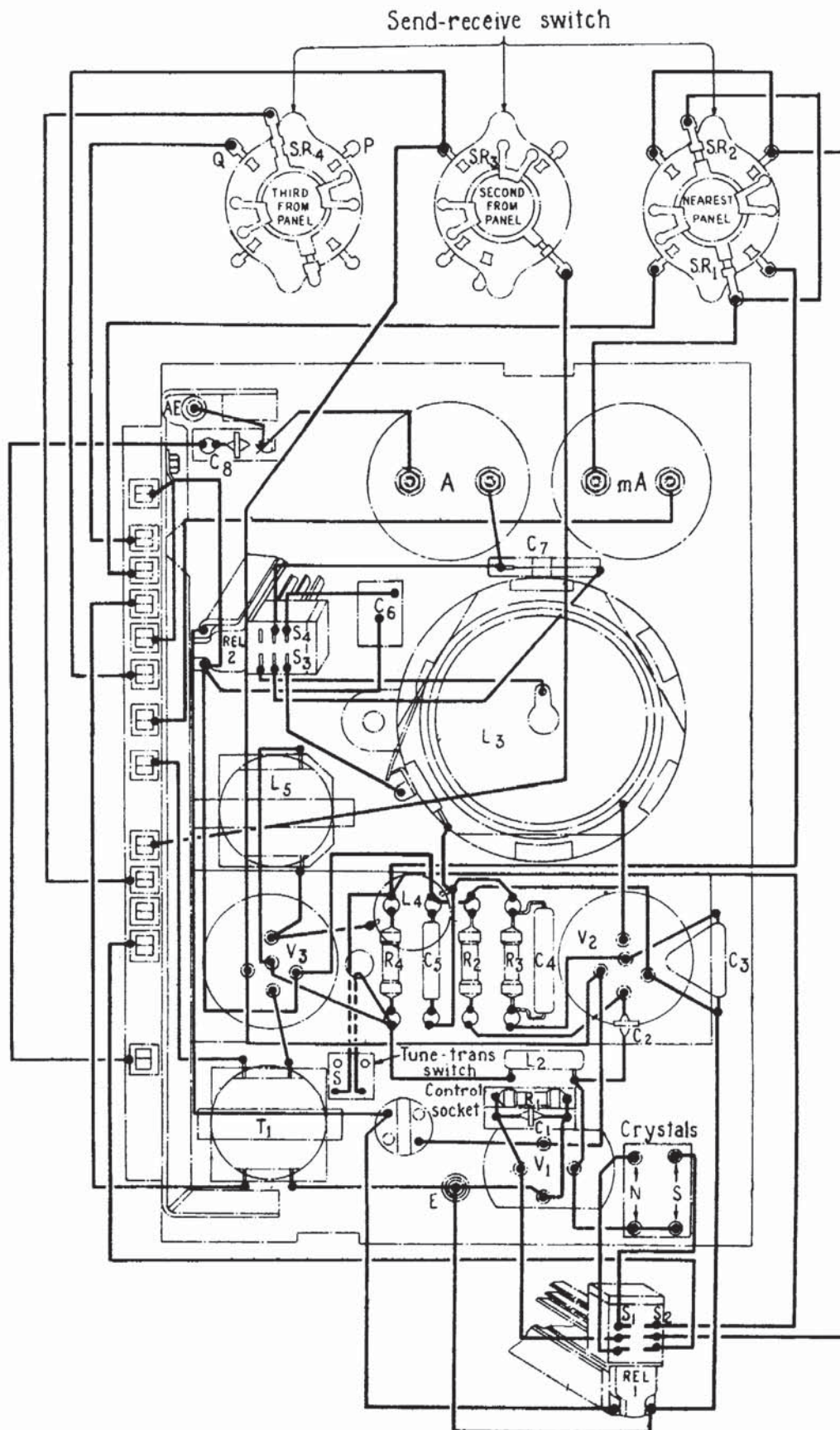


FIG.10 BENCH WIRING DIAGRAM OF T.1119

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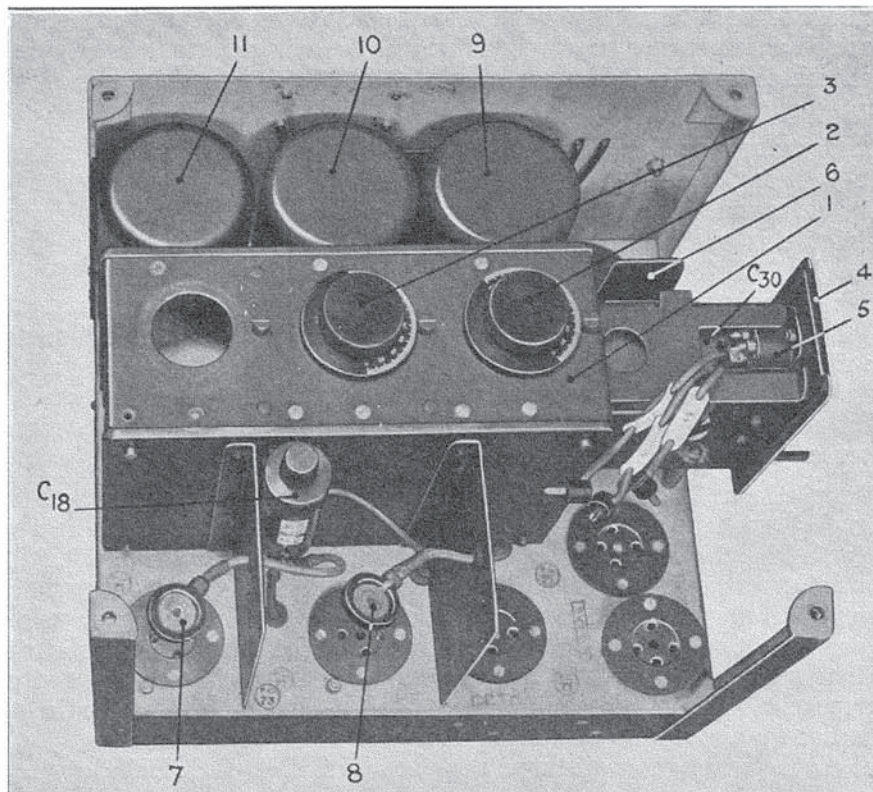


FIG. 11. RECEIVER R.1120, FRONT VIEW.

amplifier valves, are in the adjacent compartment, separated from the second R/F valve by another metal partition. The tuned anode inductances are enclosed in the screening cans (9), (10), the can (11) being empty.

47. The remainder of the components are fitted below the main panel, the space being about 2 in. deep. It is divided into four bays by means of screening partitions, as shown in fig. 12. For descriptive purposes these will be numbered from right to left, when the contact bar connections are at the top. A bench wiring diagram of the instrument is shown in fig. 13.

48. Referring to fig. 12, the first bay contains the condenser (C_{35}) with a 0.5 megohm resistance (R_2) in parallel. Near these, but mounted upon the inter-bay partition, is the R/F choke (L_9). An insulating platform, fitted to the underside of the main panel, carries two resistances. The first resistance (R_{24}), is of 10,000 ohms. All the above named components are in the grid circuit of the first R/F valve. The second resistance (R_7), is of 20,000 ohms, and is the screen decoupling resistance for the first R/F valve. The corresponding screen by-pass condenser (C_9), of 0.5μ F, is mounted on the inter-bay partition. The valve-holder (1) carries the first R/F valve, and adjacent thereto is its filament resistance (R_6).

49. In the second bay, the connections for the anode tuning inductance (L_6) of the first R/F valve are brought through a circular orifice. Adjacent thereto, but mounted on the inter-bay partition, is the 0.5μ F condenser (C_{20}), which acts as a decoupling condenser in the first R/F anode circuit. Two other condensers are also mounted on the inter-bay partition, one on each side. On the left is the 0.5μ F condenser (C_{16}), which is the screen decoupling condenser for the second R/F valve, and on the right is a 0.5μ F. condenser (C_{15}), which maintains the amplitude of the oscillatory component of screen potential at a low value.

50. An insulating platform (2) in the middle of the bay, and mounted on the underside of the panel, carries the following components, *viz.*, (i) the isolating condenser C_{10} , 0.01μ F, in the

second tuned-anode circuit ; (ii) the anode-grid coupling condenser C_{17} , $0.003\mu\text{F}$; (iii) the grid leak resistance R_9 , $1\text{ M}\Omega$; (iv) the screen decoupling resistance R_{11} , $20,000\text{ ohms}$, for the second R/F valve, and (v) the screen feed resistance R_8 , $20,000\text{ ohms}$ which is common to the screen circuits of both R/F valves. Below this platform is a $0.01\mu\text{F}$ condenser (C_{21}) which is connected across the L.T. supply leads. In the illustration this condenser is partly obscured by the condenser (C_{15}). The valve-holder (3) for the second R/F valve can be seen in the lower part of the bay, with its filament resistance (R_{10}) in proximity.

51. The third bay contains the connections to the base of the second anode-tuning inductance (L_7) and above this, mounted on the right-hand partition, is a $0.5\mu\text{F}$ condenser (C_{26}) which, in conjunction with the resistance (R_{12}), of $2,000\text{ ohms}$, serves to decouple the second tuned-anode circuit from the first. This resistance is carried on a small mounting platform. The $0.5\mu\text{F}$ condenser (C_{23}) which is also mounted on the right-hand partition, is the decoupling condenser of the detector valve. The corresponding decoupling resistance (R_{14}), of $20,000\text{ ohms}$, is suspended by its own wiring in proximity.

52. A small platform (4) near the middle of the bay carries the grid leak resistance R_{13} , $0.25\text{ M}\Omega$, for the detector valve, and also the condenser C_{22} , $0.0001\mu\text{F}$, which couples the anode of the second R/F valve to the detector grid. The valve-holder (5) for the detector valve is also

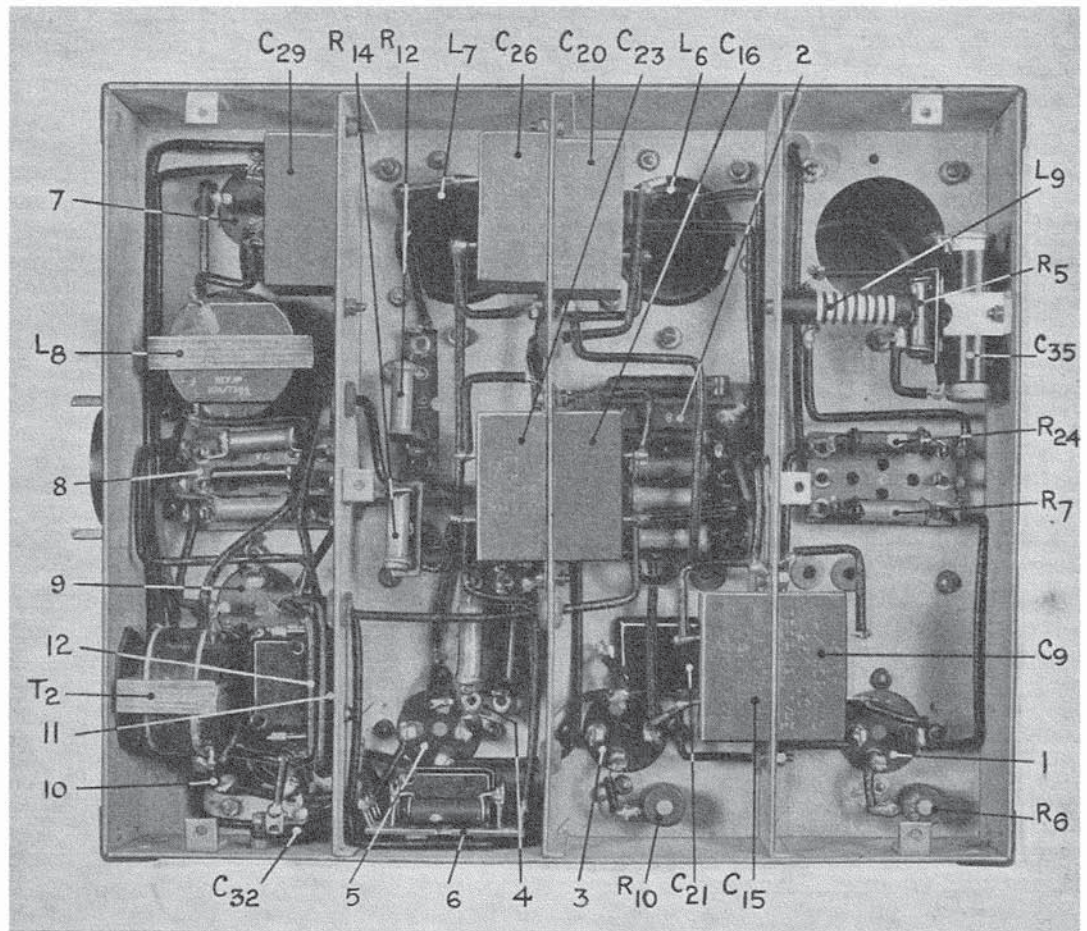


FIG. 12. RECEIVER R.1120, REAR VIEW.

fitted in this bay. On the inside of the case, an insulated platform (6) is fitted, in order to carry a bank of three resistances and four condensers. The components fitted here are (i) the grid leak

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R_{19} , 1 M Ω , for the detector valve; (ii) the grid stopper resistance R_{18} , of 2 M Ω ; (iii) the condenser C_{25} , 0.001 μ F, which is the grid coupling condenser between detector and first A/F valve; (iv) the condenser C_{24} , 0.001 μ F, which serves as a radio-frequency by-pass in the detector anode circuit, and (v) the anode load resistance R_{15} , 100,000 ohms, in the detector circuit. Only the two upper components can be seen in the diagram.

53. In the fourth bay, in line with the bases of the anode tuning inductances, is the valve-holder (7) for the output valve. On the right-hand partition is a 0.5 μ F condenser (C_{29}), which forms part of the choke-filter output circuit of the output valve. Closely adjacent is the output choke (L_8). A mounting plate (8) near the middle of the bay carries (i) the resistance R_{22} , 1 M Ω , which is the grid leak for the output valve, (ii) the grid coupling condenser C_{28} , 0.001 μ F, and (iii) the resistance R_{21} , 200,000 ohms, which is the anode load resistance of the second A/F valve. The valve-holder (9) for the latter is in close proximity to the mounting plate, and below this is the valve-holder (10) for the first A/F valve. The microphone transformer (T_2) is mounted on the side of the case and partly obscures the two lower valve-holders.

54. Between the latter valve-holders, fitted on a mounting plate (11) attached to the right-hand partition, is a group of resistances and condensers, arranged horizontally one above the other. In succession from the lower one upwards, these are as follows:—(i) the resistance R_{20} , 1 M Ω , which is the grid leak for the valve V_8 ; (ii) the grid coupling condenser C_{27} ; (iii) the resistance R_{17} , 20,000 ohms, in the anode circuit of the valve V_7 ; (iv) the resistance R_{16} , 0.5 M Ω , in series with the secondary winding of the microphone transformer, and (v) the condenser C_{31} , 30 μ F also in series with the secondary winding of the microphone transformer. This condenser is, however, normally short-circuited by a link (12) of copper wire.

55. It is most important to observe that the receiver is supplied with this link in position, for use with an electro-magnetic microphone. If a carbon microphone is to be used, this link must be removed, taking care not to reduce the electrical efficiency of the remaining connections to the condenser (*see* para. 111). On the inside of the case, near this bank of components, the 0.0002 μ F condenser (C_{32}), is mounted upon a separate support, and it is also in series with the secondary winding of the microphone transformer.

Case

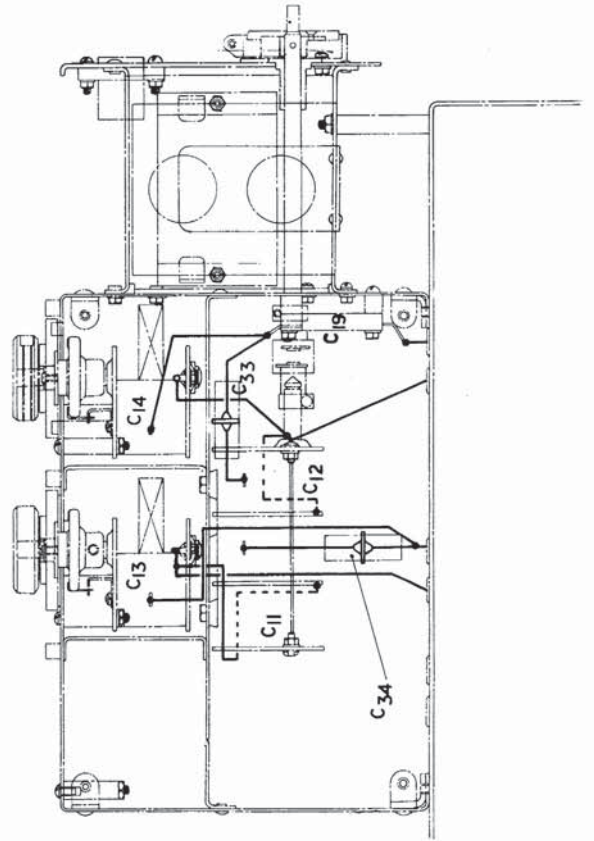
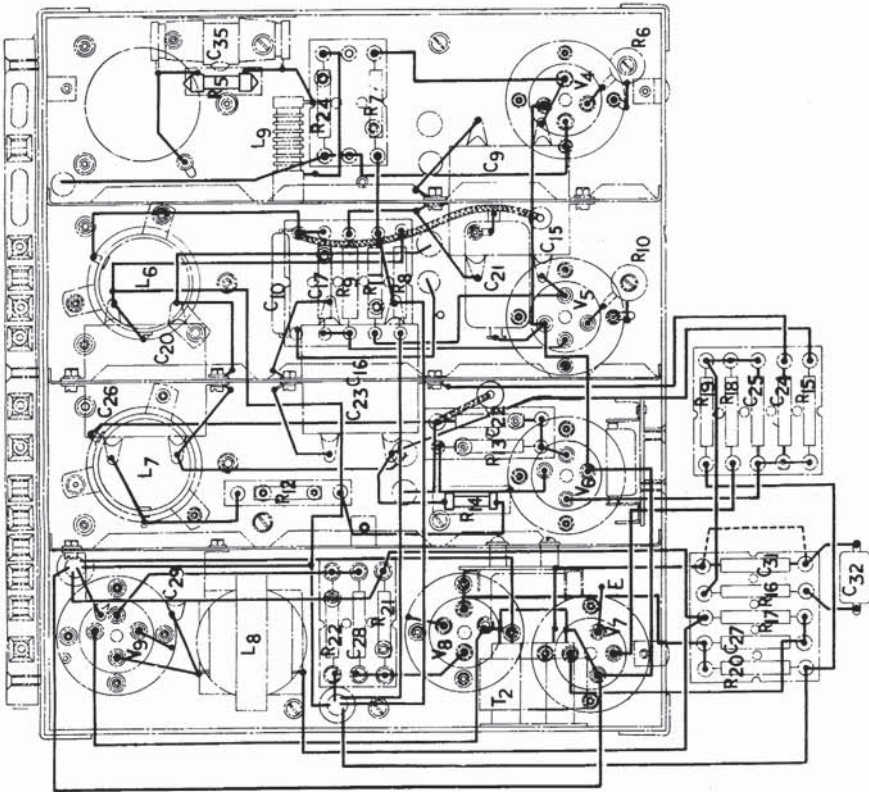
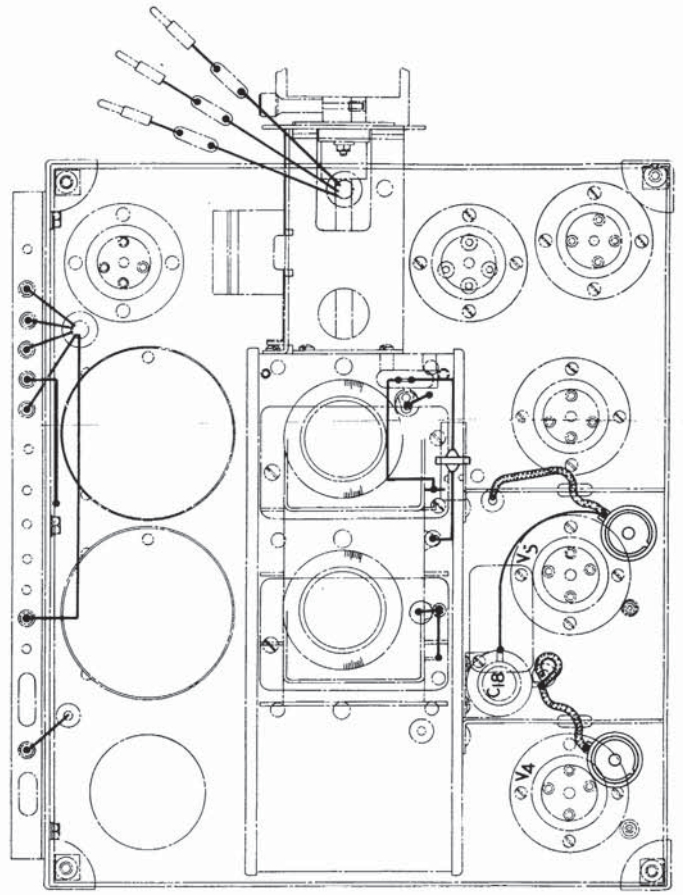
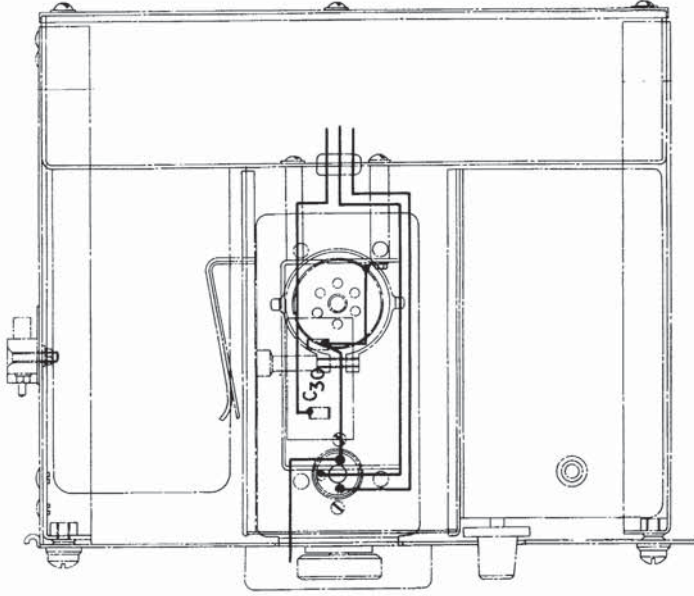
56. The transmitter and receiver units are housed together in a special case. They are shown in position in fig. 7 and in fig. 14 the case of the T.R.9D is shown with the units removed. The case is of metal and is painted grey. A main contact bar (1) shown in fig. 14 is fitted in the case, and from the underside of the contacts flexible connections are taken out through a bush. When the units are in position, spring-jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray (2) is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads (3) terminating in plugs the batteries are connected up to three spring-jaw contacts (4) on the tray, and when the tray is in position these three contacts engage with three knife contacts on the underside of the main contact bar.

Transit case

57. A transit case is provided for carrying the transmitter-receiver. It is constructed of yellow deal and is painted grey. The dimensions are approximately 1 ft. 9 in. by 1 ft. 3 $\frac{3}{4}$ in. by 10 $\frac{3}{4}$ in., and the case accommodates the complete instrument. The hinged lid is fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROLS

58. The T.R.9D transmitter-receiver is intended for operation by remote controls, and three different adjustments are made by these controls. The send-receive switch and the fine tuning condensers are each operated by a flexible shaft running in a casing and actuated by a



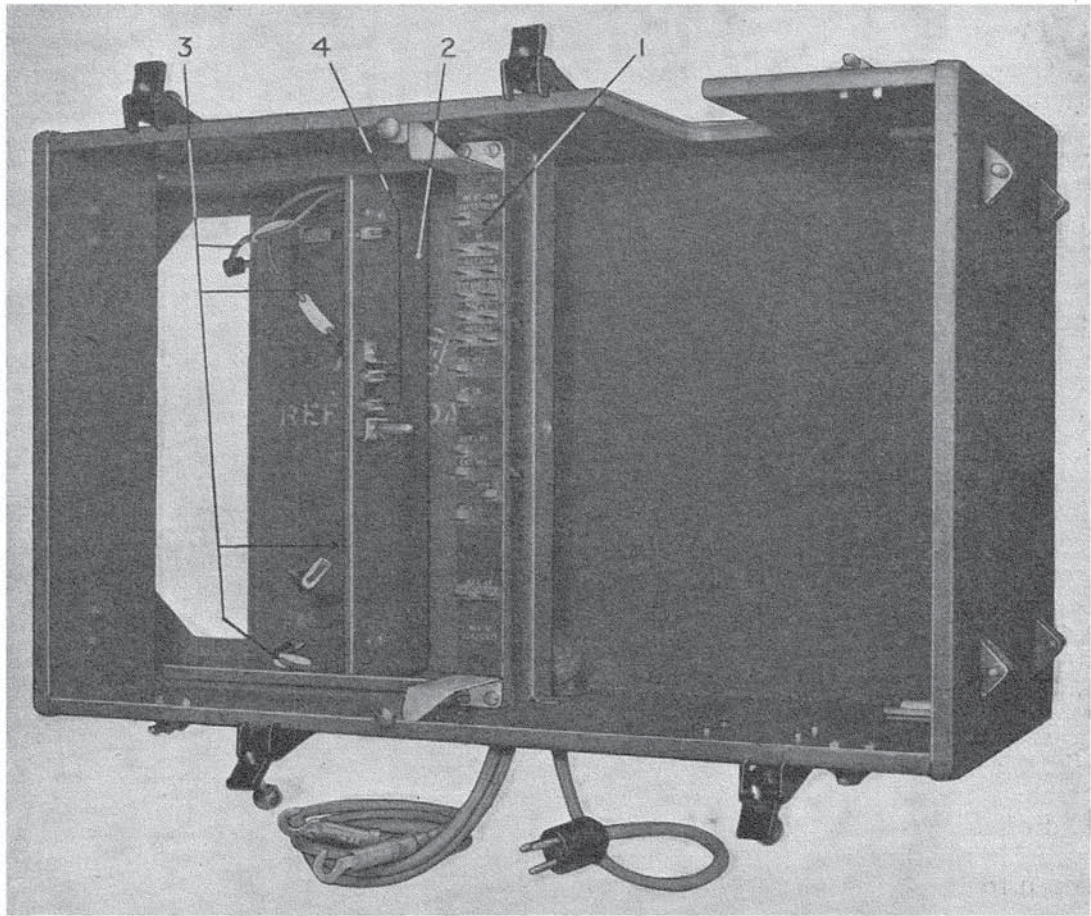


FIG. 14. CASE FOR T.R.9D.

wheel and handle. The volume is regulated by means of a potentiometer connected by a cable to the receiver in such a manner as to vary the potential applied to the screening grids of the two radio-frequency amplifiers. The three controlling handles are mounted in one unit known as the controller.

59. Two types of remote control, the type C and the type D are standardised. The type C remote controls have a flexible shaft of diameter $\frac{5}{32}$ in. for both the switch control and the tuning control. The type D remote controls are intended for installations where the shafting is 15 ft. long or more, and in this type the flexible shafting for the switch control is $\frac{3}{16}$ in. in diameter, the tuning control using the $\frac{5}{32}$ in. shafting as in the type C remote controls. Larger casing is therefore used for the type D controls, and the controller and switch coupling are modified to accommodate the larger shafting.

60. Two types C and D remote controls, as applied to the T.R.9D, are shown in fig. 15. The controller (11) is mounted in the pilot's cockpit; the switch coupling (23), condenser unit (control) (29) and the plug (26) are fitted to the transmitter-receiver. The flexible shafting (1) runs in a casing, part of which (2) is rigid and part flexible, (16) and (30). The shafting consists of a stranded core of steel wire on which is wound a helical tooth wire making about ten turns to the inch.

61. The controller consists of two parts fitted together. One part, known as the control, switch and tuning, consists of the mechanism for operating the two flexible shafts for the SEND-RECEIVE switch and the tuning condensers. The other part, the volume control, is mounted in

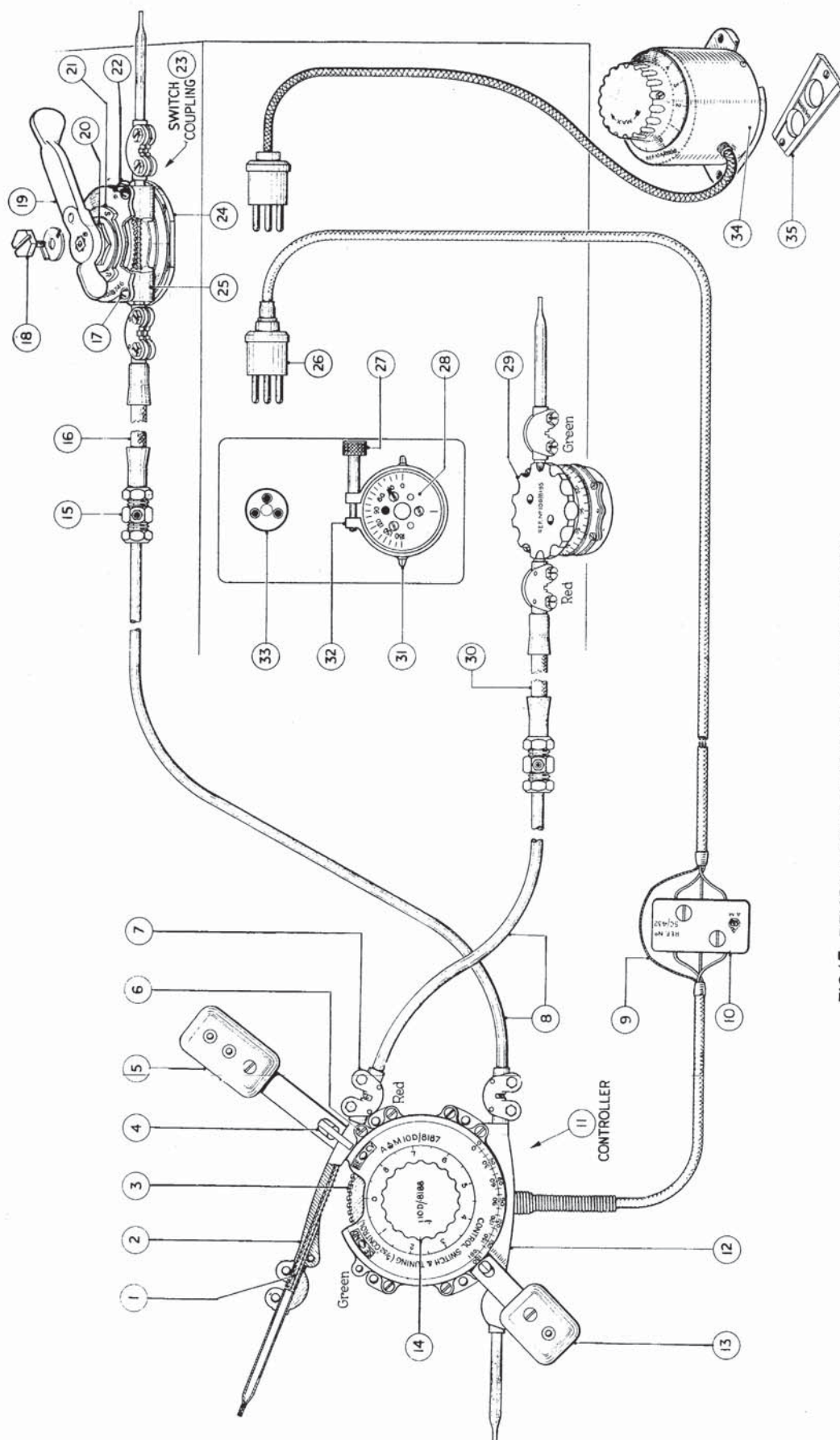


FIG. 15. REMOTE CONTROLS, TYPES C&D, FOR T.R. 9D

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the centre of the switch and tuning control and consists of a high resistance potentiometer operated by a knob.

62. The control, switch and tuning, consists of a case containing two wheels (3) with teeth specially shaped to engage with the helical tooth on the flexible shafting, so that rotation of the wheel moves the shafting in one direction or the other. The longer handle (5) is connected to the wheel which engages with the flexible shafting in the guide tube (12) and is the control for the SEND-RECEIVE switch. The other handle (13) is connected to the other wheel, and this meshes with the flexible shafting in the guide tube (2). This shafting is connected to the tuning condensers, and the handle (13) thus forms the tuning control.

63. The handles are attached to the levers by a single screw each. Three holes are provided in the switch control handle, and two in the tuning control handle, so that adjustment of the effective length of the levers is available. A spring-loaded catch (4) is fitted on the switch control handle. The central position of this handle is the OFF position, and it can be locked in this position by engaging the catch with a notch in the frame.

64. The guide tubes are attached to the body of the controller by two screws each (6), and are arranged so that if one screw is removed and the other loosened the guide tube may be swung away from the toothed wheel and the flexible shaft thus disengaged. The controller may be mounted with either of the handles uppermost, and the engraving is duplicated so that it can be read in either position. The flexible shaft may be arranged to enter either side of the controller, and the two extreme positions of the handle may be allotted for send and receive to suit the installation. The words SEND and RECV. are engraved on detachable plates which can be interchanged and turned upright to show the positions of the handle for the corresponding positions of the switch in the instrument.

65. The switch coupling (23) also contains a wheel with teeth to engage in the helical winding on the flexible shaft. On the lower end of the spindle carrying this wheel is a dog, which fits over the crossbar attached to the switch spindle on the instrument. A handle (19) is fitted on to the outer end of the shaft for local operation of the switch and as a local indicator of the switch position. As in the controller, the guide tube (25) is fixed by two screws (17) either of which may be removed to disengage the flexible shaft from the wheel.

66. The switch coupling fits on to a ring adaptor (24) which is attached to the transmitter panel by two $\frac{1}{4}$ in. by 2 B.A. countersunk screws. The sleeve and flange of the coupling are slit and are clamped to the adaptor ring by tightening the screw (22) which draws the band around the sleeve. A key inside the sleeve engages in a keyway in the upper edge of the adaptor ring. The ring has eight keyways equally spaced so that the coupling can be secured in any of eight positions on it, to allow the casing and flexible shaft to be led up to the instruments at the most convenient angle. The shaft may be led off from either end of the guide tube provided that the controller is arranged accordingly.

67. The handle (19) may be fitted on to the square end of the spindle in any of eight positions, and is secured by the screw (18) with a locking washer. The plate (21) is cut away to form a stop plate and also carries the designations S. and R. to indicate the send and receive positions. This plate can also be fixed in eight different positions to suit the position chosen for the handle. It is located by a dowel pin and secured by the nut (20) with its locking washer. The reverse side of the stop plate is also engraved S and R, but in the reverse positions. The reverse engraving will not, however, be required when the coupling is fitted to this transmitter.

68. The condenser unit (control) (29) consists of a knob fixed to a spindle turning in the body. A disc is fixed on the other end of the spindle inside the body and carries a single eccentric pin which engages in the largest of the three holes in the index wheel (28) attached to the operating spindle of the ganged fine tuning condensers. The guide tube for the flexible shaft is attached to the body by two screws, in the same way as in the switch coupling, and the flexible shaft meshes with a wheel on the spindle. The sleeve of the body fits inside the split ring (32) fixed to the receiver, and is clamped by the screw (27). The condenser unit control can be fixed in any position in the ring. A dial engraved with a scale of 0—180° on each half, forms part of the knob

One scale is marked in white and the other in orange, and the two indices (31) register with them. Whichever scale is more easily visible may thus be used. One end of the guide tube is coloured red and the other green, and the ends of the guide tube on the controller are also marked with these colours. The flexible shaft must be led off from the red end of both or the green end of both in order to obtain the correct direction of the rotation of the condenser.

69. The rigid casing (8) for the flexible shaft consists of solid-drawn light-alloy tubing. The flexible case (16) and (30) is built up of a helix of brass strip over which is a winding of steel wire and another of phosphor-bronze or spring steel wire and, finally, a waterproof covering of varnished cotton braid. The junctions between the casing and the components and between two lengths of casing are made by means of casing unions (7). The free ends of the shafting at the controller, the switch coupling, and condenser unit handle are protected by short lengths of rigid casing fitted to the free ends of the guide tubes by casing unions, and pinched up at the ends.

70. The union consists of two split clips made in one piece, and each clip is clamped up on the casing by means of a screw. A hole is drilled through the union at each end to take a key pin for increased security. These pins are not fitted, however, in the unions at the free ends. Special unions (15) to allow of lubrication are fitted between the flexible and the rigid casing, and along the run of the rigid casing when necessary. These lubricator unions carry a standard grease nipple, and have a union nut at each end. The union nut is tightened up on to a cupped washer inside the body, which is thus flattened out and bites into the tubing.

71. The volume control consists of a high-resistance potentiometer operated by the knob (14). Two different methods of construction are used for the potentiometers in service. One type is built up as an ordinary strip-wound resistance with a contact arm moving over it. The other type consists of a number of resistances connected to contacts on a multiple-contact rotary switch. This type is shown diagrammatically in fig. 16. Forty-four resistances of 1,250 ohms, each with a centre tapping, are mounted round the spindle and connected to the contacts as shown. The ends of this circuit are connected to the H.T. supply with a further resistance of 20,000 ohms in the positive lead, and the contact arm is connected to the screening grids of the valves. The 20,000 ohms resistance connected in series with the potentiometer has the effect of limiting the range of variation of the screen-grid voltage to that required for smooth control of the amplification from a minimum to a maximum.

72. A 2-ft. length of screened three-core cable is supplied with the controller and is connected, on installation, to a 3-way terminal block (10). The connections are taken from the terminal block to the three-pin plug (26) for connection to the socket (33) in the side of the receiver. The screening conductors of the two lengths of cable are connected by the bonding wire (9), which is bound to the metal braiding by 30 s.w.g. tinned copper wire soldered in position.

73. As the receiver will not function without the potentiometer connected to the socket (33), a type B volume control (34) is provided for use by an observer having access to the transmitter-receiver in a two-seater aeroplane, or for operation of the receiver on the test bench. The type B volume control consists of the potentiometer forming the type A volume control, as used in the controller, fitted into a metal case and having a lead and three-pin plug connected to it. It may be fixed in any convenient position by two screws through a flange; or the wedge plate (35) may be attached to the airframe and the volume control supported on it when easy detachment is required.

74. A key diagram showing the components required for remote control of the T.R.9D transmitter-receiver is given in fig. 17. The upper sketch shows the type C controls, and the second sketch, the type D controls as used with these instruments. In the bottom sketch the type B controls are shown. The switch coupling can be attached directly to the plate on the receiver to which the ring adaptor is otherwise fixed. The ring adaptor will not be required, and must be removed. The condenser unit handle requires an adaptor for the type B controls. This adaptor consists of a sleeve to fit into the clamp ring, (32) on fig. 15, with a spindle carrying two discs. The inner disc has an eccentric pin to engage in the largest hole in the index plate (28), and the other is arranged to fit the condenser unit handle of the type B controls.

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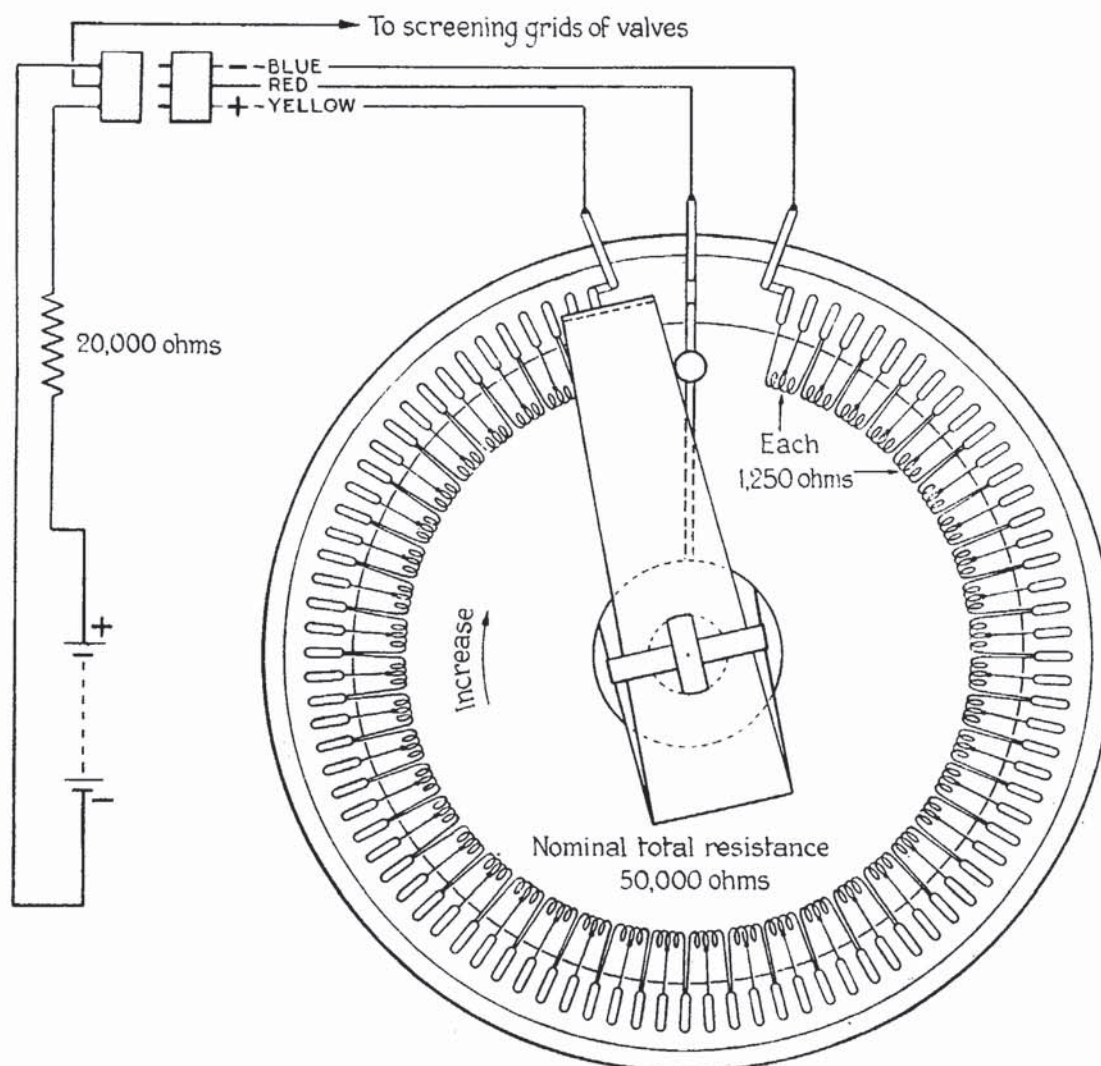


FIG. 16. VOLUME CONTROL CIRCUIT.

VALVES AND BATTERIES

75. The valves used in the transmitter are as follows:—In the oscillator stage, a valve V.T.50 is employed. This is a directly-heated triode having a filament rating of 0.1 amperes at 2 volts. It is non-metallized and is fitted with a standard 4-pin base. The maximum H.T. voltage is 150 and it is capable of dissipating 1 watt continuously. The normal anode current is about 3.0 mA. In both modulator and power amplifier stages, the valve is a V.T.51 (Stores Ref. 10E/10946). This is a directly-heated pentode having a filament rating of 0.2 amperes at 2 volts. The maximum H.T. voltage is 150 and it is capable of dissipating 3 watts continuously. The normal anode current is about 9 mA and the screen current about 2.5 mA.

76. The receiver employs two tetrodes, V.R.18, each having a filament current of 0.2 amperes at 2 volts, a detector valve V.R.27 (0.1 ampere, 2 volts), two audio-frequency amplifier valves V.R.21 (0.1 ampere, 2 volts) and a power amplifier valve V.R.22 (0.2 amperes, 2 volts).

77. Since all the valve filaments are heated during transmission, the total load on the L.T. battery is about 1.4 amperes. To this must be added the operating current for the frequency changing relays, and the microphone current, making the total current about 1.6 amperes.

78. The current for the transmitter and receiver valve filaments is supplied by a 2-volt lead-acid accumulator. If a 14 Ah. type B accumulator is fitted, it will serve for about 6 hours.

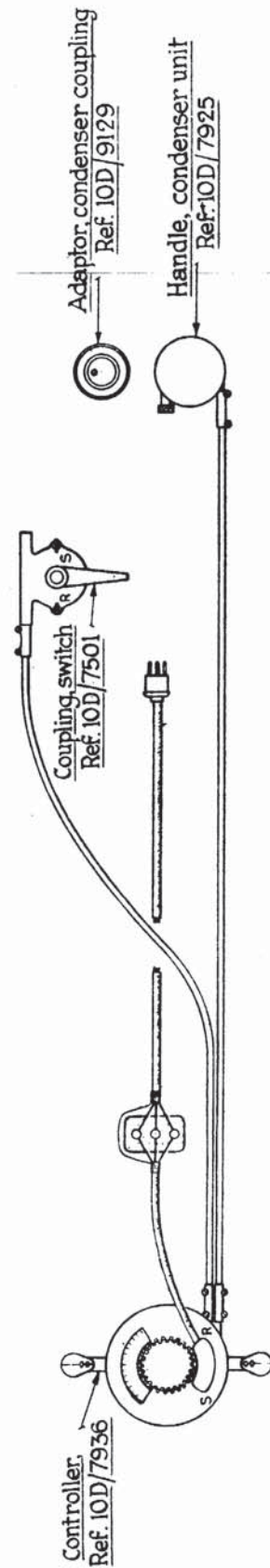
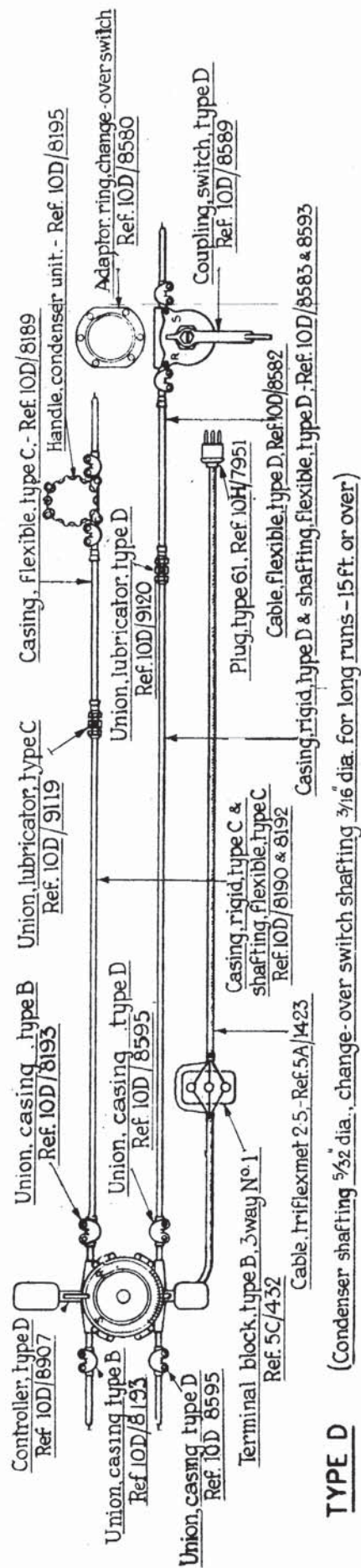
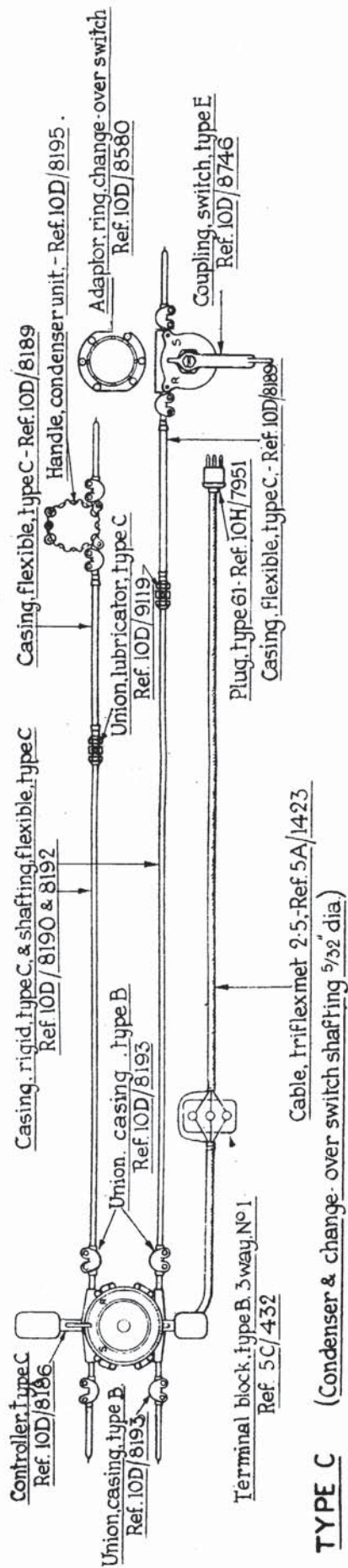


FIG. 17. REMOTE CONTROL COMPONENTS

continuous use, when on the border-line of serviceability as defined in R.A.F. Form 480, para. 33. In its earlier life it should of course provide a longer service, but as a precaution, the accumulator should be changed after every operational flight of approximately full duration. Where a 20 Ah. Type B accumulator is fitted, and is on the border-line of serviceability, it should provide for 8½ hours continuous flight, but should be changed after every second flight of approximately full duration. The 20 Ah. accumulator will eventually be standardized for use with this installation. The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery housed in a tray which is part of the case.

79. A 15-volt dry battery supplies the grid bias voltage for the modulator valve, and a 4½-volt dry battery provides the grid bias voltage for the sub-modulator stage. The former is housed in the transmitter battery tray but the latter is accommodated in the receiver itself.

80. During transmission, the H.T. battery is called upon to give an input current to the transmitter and sub-modulator, amounting in all to about 28 milliamperes. The H.T. battery will therefore require replacement more frequently than in the transmitter-receiver type T.R.9.B. It should be tested frequently, and replaced if the terminal voltage falls below 100 volts on load.

Installation

81. A typical installation diagram is given in fig. 18. It will be seen that the transmitter-receiver is fitted in a specially designed crate by means of the usual type of suspension. The crate also carries the master contactor and the 2-volt L.T. accumulator. The latter is connected to the transmitter by leads supplied as a part of the transmitter-receiver. The master contactor is fitted with three leads 15 in. long, enveloped in a woven cover and terminating in a plug, type 33. This has 4 pins, marked —, +, 3 AND 4, 1 AND 5. The latter is internally connected to the — pin. The fixed wiring of the master contactor consists of a pair of supply leads from the general service accumulator, which terminate upon the + and — pins of a socket, type 12, into which the plug, type 33, of the master contactor is fitted. The marking of the sockets corresponds to that of the plug. From the terminals 1 AND 5 and 3 AND 4 a pair of leads is carried to a socket, type 19. The input leads of the remote contactor are connected to this socket by a plug, type 51.

82. The output leads of the contactor are fitted to a plug type 62 which is plugged into a socket, type 19. The fixed wiring of the installation is then carried to a point near the crate and terminates in a plug, type 34, which fits the control socket on the transmitter. A switchbox, type B, is fitted in a convenient position in order that the radiation of the special frequency may be suspended when necessary, without switching off the remote controller and so throwing it out of synchronism.

83. The microphone and telephone leads of the transmitter-receiver terminate in a plug type 48, which connects up to the fixed wiring *via* a socket, type 17. The fixed wiring, both of the microphone and the telephone circuits, is of metal braided cable (duflexmet 2.5) the braiding being earthed at the ends of each run. Standard sockets, type 29, are fitted for the accommodation of the plug, type 119, fitted to the cord of the mask microphone. The remote controls are also shown in this diagram.

TUNING

Transmitter

84. Since the oscillator is crystal controlled, no wavemeter is necessary for the tuning of the transmitter. Frequency-control crystals, complete in mountings, have been allocated a separate section in Air Publication 1086 (Priced Vocabulary of Royal Air Force Equipment), to be known as Section 10X. The stores reference number of a crystal is identical with that of its frequency in kilocycles per second. The nomenclature of a crystal complete in mounting, consists of the word "crystal" followed by its frequency expressed verbally, thus 10X/5320, crystal, five three

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two zero, indicates a crystal having a natural frequency of 5320 kc/s. On no account are crystal mountings to be opened up or repaired by service units or by depots.

85. The procedure for tuning the transmitter to a pair of predetermined (i.e., normal and special) frequencies, is as follows :—

- (i) Remove the transmitter from the instrument case.
- (ii) Insert a 120-volt H.T. battery and a 15-volt grid bias battery in the battery tray and connect the appropriate plugs. Take particular care that the grid bias is set to -10.5 volts.
- (iii) Insert the crystal oscillator valve V.T.50 and replace the transmitter in the case, ensuring that the SEND-RECEIVE switch is in the OFF position and the limiting resistance switch to TUNE.
- (iv) Select a pair of crystals of the desired frequencies, ensuring that the "normal" crystal is plugged into the holder N and the "special" crystal into the holder S.
- (v) Connect the L.T. leads to the 2-volt accumulator.
- (vi) Connect the aerial and earth to the appropriate terminals of the transmitter.
- (vii) See that the control socket is unoccupied, so that the relays are in the "normal" position. Ensure that the short-circuited plug, type 118, (red top) is available for use when required.
- (viii) Set SEND-RECEIVE switch to SEND. Since the amplifier and modulator valves are not yet in position, only the sub-modulator and oscillator valves will take current. The milliammeter should indicate a feed current of not more than 4.5 mA.
- (ix) Insert the short-circuited plug, type 118, in the control socket. This should cause the relays to operate, changing to the "special" position; observe the feed current. This should not exceed 4.5 mA.
- (x) Set SEND-RECEIVE switch to OFF, and remove the short-circuited plug, type 118.
- (xi) Insert the amplifier and modulator valves V.T.51.
- (xii) Set the SEND-RECEIVE switch to SEND.
- (xiii) Adjust the normal aerial tuning inductance to obtain minimum input current. It will be found that the aerial current is very nearly a maximum at this point. The input current should be of the order of 13 mA, and the aerial current should be about 0.13 amperes.
- (xiv) Set the limiting resistance switch to TRANSMIT.
- (xv) Trim aerial inductance for minimum input as before.
- (xvi) Set SEND-RECEIVE switch to OFF.

This completes the tuning of the normal frequency. The special frequency is tuned as follows :—

- (xvii) Select a suitable tapping on the aerial coil by means of the control marked S.AE COARSE, and adjust the condenser S.AE FINE to about 4.
- (xviii) Return the limiting resistance switch to TUNE.
- (xix) Insert red-topped plug, type 118, in the control socket.
- (xx) Set SEND-RECEIVE switch to SEND.
- (xxi) Adjust S.AE FINE control for minimum input. Unless a definite minimum is obtainable,
 - (a) Put SEND-RECEIVE switch to OFF and
 - (b) try an adjacent tapping on the S.AE COARSE control. The input current should be of the order of 13 mA, and the aerial current should be about 0.13 amperes.
 - (c) When a definite minimum input is observed.

(xxii) Set limiting resistance switch to TRANSMIT and re-adjust S.AE FINE control for minimum input as before.

The special frequency is now correctly adjusted.

(xxiii) Put SEND-RECEIVE switch to OFF and remove red-topped plug, type 118, from control socket.

NOTE.—When tuning on the bench before installation, an artificial aerial type 3 may be used instead of an aerial and earth. The capacitance should be set to $100\mu\mu$ F. When re-tuning a transmitter which has been in use previously, the stages (i) to (xi) are omitted, except that appropriate crystals must be inserted as in (iv) if the frequency allocation has been altered.

86. The following table may be used as a guide for preliminary settings of the aerial tuning for both normal and special frequencies.

Crystal frequency kc/s	Crystal in socket	Red- topped plug	N aerial tuning		S aerial tuning		Input mA	Output amperes
			Turns	Degrees	Coarse	Fine		
6.6	N	out	5	330			24	0.25
6.0	N	out	7	100			24	0.25
5.75	N	out	7	310			24	0.25
5.3	N	out	9	40			24	0.25
4.75	N	out	11	20			24	0.25
4.25	N	out	13	200			24	0.25
6.66	S	in			4	2.0	25	0.23
6.0	S	in			5	2.5	25	0.23
5.75	S	in			5	8.0	25	0.23
5.3	S	in			6	8.0	25	0.23
4.75	S	in			8	5.0	25	0.23
4.25	S	in			10	5.0	25	0.23

Receiver

87. Since the aerial circuit of the transmitter is the input circuit of the receiver, the transmitter must invariably be tuned to the desired frequency before attempting to tune the receiver. Until a suitable type of crystal monitor is generally available, the receiver may be tuned by means of an R/T tester, Unit A, which has previously been modified in accordance with the instructions contained in A.P.1186/E.36. This modification consists of the introduction of a crystal for stabilizing the frequency of the modulated oscillation generated by the R/T tester; when used in this manner, a valve V.R.21 is used as a modulator and a valve V.T.20 as an oscillator. The R/T tester, Unit A, is set up to the desired frequency as follows. Insert a crystal of the required frequency into the crystal adaptor. Using the telephone plug and lead supplied with the R/T tester, connect a testmeter, type C, to the jack on the instrument panel. Set the testmeter to the 0—30 mA. range, and the R/T tester to transmit T.T. The latter operation completes the filament circuit of both valves and the oscillations will then be initiated. Adjust the variable condenser until the reading of the testmeter is a minimum. This adjustment is critical, but is facilitated by the fact that the setting of the condenser dial in kc/s should agree approximately with the frequency of the crystal. Having determined the condenser setting giving minimum input, increase the condenser reading by 15 kc/s., lock the condenser dial and withdraw the plug of the testmeter. The R/T tester, Unit A, is now radiating a modulated crystal-controlled oscillation.

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88. The following instructions are generally applicable, no matter what form of signal generator is used to produce the tuning signal, except where specific reference is made to the R/T tester Unit A.

- (i) Turn the volume control potentiometer in the pilot's cockpit to the maximum volume position. Except, as stated in sub-para. (viii), it must be maintained in this position during the whole of the operation of tuning.
- (ii) Set the fine tuning control to 90 degrees, *i.e.*, to the middle of its range of movement.
- (iii) Place the signal generator near the tail plane. Where a modified R/T tester, Unit A, is used for this purpose, the screening lid should not be securely closed during the preliminary tuning.
- (iv) Put SEND-RECEIVE switch to RECEIVE, and adjust the two main tuning condensers until the modulated signal is heard at maximum strength.
- (v) Progressively weaken the field strength at the receiver, first by closing and securing the screening cover of the Unit A where used and, if necessary, by removing the unit further from the receiver. In no circumstances should the signal strength be decreased by adjustment of the receiver volume control. Where crystal monitors are available, an attenuator is fitted as an integral component, and this control is used to reduce the field strength instead of the somewhat haphazard method which must be adopted with the R/T tester, Unit A.
- (vi) Having attenuated the field at the receiving aerial until signals are barely audible when the receiver is exactly in tune, turn the regeneration control in the direction of the arrow until the receiver commences to oscillate, then turn back one complete turn.
- (vii) Re-adjust the two main tuning condensers for maximum signal strength.
- (viii) Operate the volume control, ensuring that the strength of signals decreases and increases over the entire range of variation and that oscillation does not set in at any point in the range. Return the control to the maximum position.
- (ix) Rotate the fine tuning control over the whole of the range, ensuring that the instrument is stable, and return it to the original position, by observation of maximum signal strength.
- (x) Should oscillations set in during the operations described in (viii) or (ix), repeat the whole tuning operation up to (v). In operation (vi) the regeneration control should be turned back $1\frac{1}{2}$ turns from oscillation point instead of 1 turn, then proceed as in (vii), (viii) and (ix).

OPERATION AND MAINTENANCE

General

89. When the aeroplane is on the ground, the switch handle of the controller should be locked in the OFF position as a safeguard against battery wastage. Immediately before leaving the ground the handle should be moved to the RECEIVE position and continuously maintained in this position except when transmission is in progress on the "normal" frequency, so that it is always possible to receive a call.

90. Immediately before each flight a test of transmission and reception should be made. During flight, the SEND-RECEIVE control and volume control are operated as required. If the receiver has been tuned in accordance with the preceding instructions the receiver fine tuning control should not require adjustment during the flight. It is again emphasized that a carbon microphone must not be used unless the shorting link across the attenuating condenser (C₃₁, fig. 2) is previously removed (*see* para. 111).

91. Since the aerial circuit of the transmitter also functions, during reception, as the input circuit to the first R/F stage, it is essential that all inter-communicating transmitters shall be

on exactly the same frequency. If this is not the case, the input circuit of the receiver may not be in resonance with a received signal, and the signal strength may be poor.

92. The L.T. accumulator must be removed and charged at frequent intervals. If a 14 Ah. accumulator is fitted, a newly charged one should be installed before each flight in which the wireless apparatus is to be used. Where the 20 Ah. type is fitted, the accumulator should be replaced by a newly charged one after each two flights of approximately full duration.

93. The H.T. battery voltage should be tested periodically. This may be done either by withdrawing the battery tray, or by removing the cover of the contact bar and connecting the voltmeter between H.T.+ and H.T.— contacts. If the voltage on load falls below 100 volts the battery must be renewed. The plugs should be secure in the battery sockets and care must be taken not to dislodge them in replacing the battery tray. As already stated the H.T. battery is called upon to supply a total current of about 28 milliamperes.

94. The voltage of the transmitter and receiver grid bias batteries should also be checked periodically, and the security of the plugs attended to. If the voltage of either is low, the modulator or sub-modulator, as the case may be, will take a heavy anode current and transmitted speech will be distorted. A defective receiver grid bias battery will also give rise to distorted speech during reception.

95. On no account should any attempt be made to remove or replace any plug or valve, unless the SEND-RECEIVE switch is in the OFF position, except that the relays may be operated for testing and tuning by the insertion and withdrawal of the plug, type 118, supplied for this purpose.

96. The relays themselves should seldom, if ever, require adjustment, but if this should become necessary it is not to be attempted except by means of the proper tools, which are contained in the kit specified in Section V, Chapter XVI (Ground Station Remote Controls, Table I), of this Air Publication. The relays should operate on the closure of the circuit, *e.g.* by the insertion of the plug, type 118, into the control socket, provided that the terminal P.D. of the L.T. battery is above 1.8 volts. The minimum "break" between any two pairs of contacts should be 0.04 in. On "making" in either direction the contacts should "follow through" for at least 0.02 in.

Master Contactor

97. If any doubt arises as to the accuracy of the master contactor, its regulation should be checked by means of a stop watch Mark VI, which is available for use with this installation. It is not necessary to remove any apparatus from the aeroplane, but the remote contactor must be installed and not the dummy one. The master contactor is fully wound and started by means of the starting knob. At least ten minutes should be allowed for the interior of the clock to attain its working temperature (75° to 80° F.) and for the balance wheel oscillation to settle down to a steady rate. See that the switch of the master contactor is OFF and set the adjustable index to 0°, aligning the pointer to it. Fully wind the stop watch and set it to zero.

98. When ready to take the first or rough check, start the stop watch and simultaneously start the remote contactor by moving the switch to ON. Take the time of 15 complete revolutions. This should take 15 minutes exactly. If, however, it actually takes 15 minutes 0.5 second, the master contactor is obviously losing 2 seconds per hour. It is unlikely that the rate of the clock will be so high as this. If it is considerably less, however, it is not possible to check it with accuracy over such a short period as 15 minutes. The remote contactor and the stop watch should therefore be left running for six hours. Suppose that at the end of six hours run, the hand of the remote contactor is 1/10th of a revolution past the index, then the master contactor has gained 1/10th of a minute in six hours, *i.e.* is gaining one second per hour. If the master contactor gains or loses more than this, the accuracy is below the operational requirements of the installation. The object of the preliminary check is to guard against the remote possibility that this is actually a gain of 1 1/10th minute or a loss of 9/10th minute per six hours.

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99. For simplicity it has been assumed that the stop watch Mark VI has no rate of gain or loss. The actual rate of the watch should be checked by comparison with a watch of known rate or by wireless time signals. In the latter case, however, it must be remembered that the watch runs for six hours only on a single winding. Since under certain conditions the pilot will use the clock on the instrument panel in conjunction with the radio installation, it is convenient to obtain the relative rates between this clock and the master contactor during the above test. After performing a six-hour test, the L.T. battery should always be replaced by a fully charged one.

Remote controls

100. When the remote controls are to be disconnected for removal of the transmitter-receiver from the aeroplane the switch coupling is removed by loosening the clamp screw and pulling the coupling off the adaptor ring attached to the panel, and the condenser unit handle is removed in a similar manner. The positions at which each of these has been fitted should be noted before they are removed. The volume control plug must also be taken out.

101. When the transmitter-receiver is replaced, the switch coupling and condenser unit handle should be fitted in the same position as before unless there is particular reason for changing them. The correct position for the switch coupling may be determined, if it is not known, by putting both the switch and the handle of the coupling in the OFF position and engaging the dog with the switch cross bar. The key should then fit into the appropriate keyway. The condenser unit handle is not keyed and the correct position must be found by trial.

102. If the shafting has been disengaged from the wheels, or if the position of the switch coupling or condenser unit handle changed, the shafting must be re-adjusted. When the switch coupling has been fitted in the new position and fixed by tightening the clamp screw the most convenient position for the handle is then decided on and the OFF position noted. The stop plate is moved if necessary to correspond with the range of movement decided on for the handle and the handle then fitted. The condenser unit handle is fixed as required and clamped up.

103. The flexible shafting must then be re-adjusted. The following method is observed in the initial fitting and should be repeated if the shafting has been disturbed. It is assumed that the casing and components are completely assembled.

- (i) Disconnect the short closed lengths of tubing from the controller and coupling by disengaging the casing unions from the guide tubes.
- (ii) Remove one of the screws fixing each guide tube, slacken the others and swing the tube away from the wheel.
- (iii) Thread the required length of shafting into the casing and push it through until the end is just flush with the free end of the guide tube on the coupling.
- (iv) Turn the handle on the coupling to the position that it would occupy if the shafting were engaged with the wheel and then pulled from the far end. Push the guide tube back into place, meshing the shafting and wheel to the nearest tooth, and screw up the guide tube.
- (v) Pull the end of the shafting projecting from the controller so as to take up all slack. Turn the handle of the controller to the position it would occupy to pull the shafting as far as possible from the other end and refix the guide tube, meshing the shafting and wheel to the nearest tooth. It should now be possible to operate the coupling to either extreme position by movement of the controller handle. When the shafting is pushed away from the controller to its extreme position, the end should be flush with the free end of the guide tube.
- (vi) If there is an intermediate switch coupling for operation of the SEND-RECEIVE switch by the observer, the switch handle of the controller should be placed in the OFF position and locked. The handle of the intermediate coupling should then be turned to the central position and the guide tube pushed into place and screwed

up. With the controller handle unlocked, it should then be possible to operate the switch to either extreme position by movement of the intermediate handle.

(vii) Replace the short closed lengths of rigid casing on the free ends of the guide tubes.

104. If in the repair or modification of remote controls, it is required to bend the rigid casing, the bending tool supplied for the purpose must be used. The bending tool is of wood and is in the shape of a segment of a circle, with a U-section slot round the edge in which the casing is to be fitted for bending. For the type C rigid casing the tool, bending, type C, is used, and for the type D rigid casing the tool, bending, type D and the following precautions must be observed.

- (i) The cross-section of the casing must not be distorted from the circular form. The appropriate flexible shafting must therefore always be threaded through the casing before the casing is bent.
- (ii) The straight casing adjacent to a bend must be tangential to the bend. The bending tool is to be placed against the casing where the bend is required and the casing bent by hand to the shape of the tool. The bending must be done slowly and without jerks.

Electro-magnetic microphone

105. Periodic inspection of the electro-magnetic microphone should be carried out. The front cover and diaphragm should be removed and any moisture which has condensed on the wax filling or on the diaphragm should be removed with a clean soft white cloth. Before reassembly a thin layer of petroleum jelly should be applied to the rim of the body of the instrument.

106. Tests of microphone resistance, lead screen resistance, insulation resistance and microphone efficiency may be carried out with the following apparatus:—Insulation Resistance Tester, Testmeter, Type A or D, Noise Generator, No. 1, and Condenser, Type 112 or 330. All microphone and telephone connections should be carefully checked before carrying out the tests.

107. Microphone resistance test. Withdraw the microphone-telephone plug and connect the testmeter, on ohmmeter scale, across the microphone contacts on the plug, rings 2 and 3 (counting the tip as ring 1). With the microphone switch at ON, the ohmmeter should read approximately 60 ohms. A faulty microphone will be indicated by a reading which is over 75 or under 45 ohms.

108. Lead screen resistance test. Connect the testmeter between Tel.— (ring 4 of the plug) and the earthing terminal on the back of the microphone. The meter should indicate a very low resistance, less than 1 ohm. A higher resistance indicates a defective screen on the microphone lead.

109. Insulation resistance test. The insulation resistance tester should give a reading of greater than 40 megohms when connected between the following pairs of plug contacts, the microphone switch being in the OFF position:—(i) Mic.+ and Tel.— (rings 2 and 4), (ii) Mic.— and Tel.— (rings 3 and 4), (iii) Mic.+ and Mic.— (rings 2 and 3). If the reading is less than 40 megohms in any of these tests, repeat them after disconnecting the microphone. If these latter tests are satisfactory the fault lies in the microphone which should be tested by connecting the meter in turn between each of the microphone terminals and the earth terminal on the casing. In this way it will be possible to isolate the fault and make any necessary replacements.

110. Microphone efficiency test. Set up the transmitter-receiver T.R.9.D with a condenser, type 112 or 330, connected between the aerial and earth terminals, other connections being removed from these terminals. Insert the microphone plug in its socket, and, with a suitable crystal inserted in the “normal frequency” holder, switch on the transmitter. Tune for minimum anode current. Set the microphone switch to ON and place the front cover of the microphone against the rubber guard strips round the aperture in the noise generator. Note

SECTION 2, CHAPTER 4

the current on the aerial ammeter. Switch on the noise generator. The aerial ammeter current should increase by approximately 0.06 amps. If this current does not rise by at least 0.04 amps. the output from the microphone is unsatisfactory.

111. The transmitter-receiver, type T.R.9D, has been designed primarily for use with electro-magnetic microphones, such as microphones, type 19, but when necessary carbon capsule microphones, such as mask microphones, type E, may be used. Since the output voltage from a carbon capsule microphone is considerably greater than that from an electro-magnetic microphone, it is necessary to attenuate the gain of the common amplifier in the receiver portion of the transmitter-receiver. This attenuation is obtained by transferring the grid lead from the secondary to the primary of the microphone transformer, using the primary winding as a choke and dispensing with the transformer as such. Any transmitter-receivers T.R.9D which have been modified as above, cannot be used in conjunction with electro-magnetic microphones.

112. Any instability which may be experienced when using carbon capsule microphones, can be eliminated in the following manner. A lead should be soldered to the common negative terminal of the socket, type 17, and the other end of the lead should be connected to the nearest convenient point on the aeroplane earth system. Any instruments which have been modified, should have the original wiring restored before they are returned to Store.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Quantity	Ref. in Fig. 2	Remarks
10D/10470	Transmitter-receiver T.R.9D ...	...		
	Consisting of :—			
10D/10531	Case	1		Fitted with contact bar Ref. No. 10A/10477, leads and plug type 48.
10A/10477	Bar, contact			
10A/9172	Cover, contact bar	1		
10D/10472	Receiver, type R.1120	1		For details, see below.
10D/10471	Transmitter, type T.1119	1		For details see below.
10A/9175	Tray, battery	1		
	Principal components :—			
10A/7818	Ammeter, thermo 0—0.5	1	A	
10A/10474	Bar, contact, type 8	1		
10H/9227	Base, terminal	1		
10C/9206	Choke, H/F, type 34	1	L ₂	
10C/10117	Choke, H/F, type 37	1	L ₄	
10C/7912	Choke, L/F, type G	1	L ₅	
10D/10473	Coil, aerial	1	L ₃	
10C/8009	Condenser, type 132	1	C ₃	0.0005 μ F.
10C/9179	Condenser, type 280	1	C ₅	0.001 μ F.
10C/9185	Condenser, type 286	1	C ₄	0.01 μ F.
10C/9208	Condenser, type 289	1	C ₇	0.002 μ F.
10C/10394	Condenser, type 404	1	C ₂	10 μ F.
10C/10568	Condenser, type 410	2	C ₁ , C ₈	50 μ F. ceramic disc
10C/10476	Condenser, type 411	1	C ₆	Variable, air dielectric.
10F/10111	Head, switch	1		
10H/10478	Holder, crystal	1		
10H/9615	Holder, valve, type S	2	V ₂ , V ₃	5-pin
10H/9195	Plate, guard	2		For valve-holders
10H/10479	Holder, valve, type X	1	V ₁	4-pin
10A/7820	Milliammeter 0—30	1		
10F/10112	Plate, stop	1		
10F/10480	Relay, magnetic type 42	2	REL ₁ , REL ₂	Telephone-type, 2 makes, 2 breaks.
10C/7956	Resistance, type 103	1	R ₄	5,000 ohms.
10C/8020	Resistance, type 112	1	R ₂	30,000 ohms.
10C/8021	Resistance, type 113	2	R ₁ , R ₃	20,000 ohms.
10H/7276	Socket, type 11	1		
10F/10113	Switch, type 137	1	SR ₁ , SR ₂ , SR ₃ , SR ₄	
10F/10338	Switch, type 152	1	S ₅	
10A/10497	Transformer, L/F, type 19	1	T ₁	
10D/10472	Receiver, type R.1120	1		
	Principal components :—			
10A/10475	Bar, contact	1		Fitted with 7 contacts
10H/9190	Base, terminal, 1-way, type A	1		Engraved 16
10H/9191	Base, terminal, 2-way	1		Engraved 14 and 15
10H/9192	Base, terminal, 3-way, type A	1		Engraved 1, 2 and 3
10H/9224	Base, terminal, 3-way, type B	1		Engraved 22, 23 and 24
10H/9193	Base, terminal, 5-way, type A	1		Engraved 4, 5, 6, 7 and 8
10H/9225	Base, terminal, 5-way, type B	1		Engraved 9, 10, 11, 12 and 13
10H/9226	Base, terminal, 5-way, type C	1		Engraved 17, 18, 19, 20 and 21.

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Ref. No.	Nomenclature	Quantity	Ref. in Fig. 2	Remarks
10D/9189	Can, coil	3		
10C/10117	Choke, H/F, type 37	1	L_9	
10C/7384	Choke, L/F, type B	1	L_8	
10D/9187	Coil, anode	2	L_6, L_7	
10C/7902	Condenser, type 121	1	C_{22}	0.0001 μ F.
10C/7906	Condenser, type 125	2	C_{10}, C_{19}	0.01 μ F.
10C/8388	Condenser, type 178	1	C_{32}	0.0002 μ F.
10C/9178	Condenser, type 279	1	C_{17}	0.0003 μ F.
10C/9179	Condenser, type 280	4	$C_{24}, C_{25}, C_{27}, C_{28}$	0.001 μ F.
10C/9180	Condenser, type 281	1	C_{30}	2 μ F.
10C/9181	Condenser, type 282	7	$C_9, C_{15}, C_{16}, C_{20}, C_{23}, C_{26}, C_{29}$	0.5 μ F.
10C/9182	Condenser, type 283	1	C_{18}	Variable.
10C/9184	Condenser, type 285	1	C_{31}	0.00003 μ F.
10C/9185	Condenser, type 286	1	C_{21}	0.01 μ F.
10C/9197	Condenser, type 287	1	$C_{11} + C_{12}$	Variable.
10C/9198	Condenser, type 288	2	C_{13}, C_{14}	Variable.
10C/10554	Condenser, type 423	1	C_{35}	0.1 μ F.
10C/10948	Condenser, type 429	2	C_{33}, C_{34}	20 μ F. ceramic disc.
10H/9194	Holder, valve, type R	6	V_1, V_5, V_6, V_7, V_8	4-pin
10H/9195	Plate, guard	6		For valve-holders.
10H/9196	Plate, guide	6		For valve-holders.
10A/9202	Knob, type 1	2		
10A/9201	Knob, type 2	2		
10H/9176	Plug, type 76	3		For grid bias battery.
10C/7955	Resistance, type 102	1	R_{12}	2,000 ohms.
10C/7957	Resistance, type 104	1	R_{24}	10,000 ohms.
10C/8016	Resistance, type 108	2	R_5, R_{16}	0.5 megohm.
10C/8017	Resistance, type 109	1	R_{18}	2 megohms.
10C/8018	Resistance, type 110	1	R_{13}	0.25 megohm.
10C/7910	Resistance, type 130	2	R_6, R_{10}	1.5 ohms.
10C/8019	Resistance, type 111	1	R_{15}	100,000 ohms.
10C/8021	Resistance, type 113	5	$R_7, R_8, R_{11}, R_{14}, R_{17}, R_9, R_{19}, R_{20}, R_{22}, R_{21}$	20,000 ohms.
10C/8117	Resistance, type 123	4		1 megohm.
10C/8519	Resistance, type 145	1		200,000 ohms.
10A/9199	Ring, clamp	1		For remote control attachment.
10A/9200	Screw, clamp	1		For Ref. No. 9199.
10A/7394	Socket, type 17	1		For remote volume control.
10A/7916	Transformer, microphone, type 51	1	T_2	
10A/9203	Wheel, index	1		For remote control attachment.
ACCESSORIES				
5A/1386	Accumulator, lead-acid, 2 V., 14 Ah. type B.	1	}	For L.T. supply, according to operational requirements.
5A/1387	Accumulator, lead-acid, 2 V., 20 Ah., type B.	1		
5A/1383	*Battery, dry, 4½-V.	1		G.B. for receiver.
5A/1338	*Battery, dry, 15-V.	1		G.B. for transmitter.
5A/1333	*Battery, dry, 120-V.	1		H.T. for transmitter and receiver.
(*or appropriate overseas pattern)				

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Ref. No.	Nomenclature	Quantity	Ref. in Fig. 2	Remarks
10D/10993	Case, transit	1		For complete transmitter-receiver.
10A/10984	Contactor, type 1 } or	1		12-volt, master
10A/10994	Contactor, type 2 }			24-volt, master
10A/10985	Contactor, type 3 } or			12-volt, remote
10A/10995	Contactor, type 4 }	1		24-volt, remote
10A/10988	Contactor, dummy			Fitted with plug, type 62
10X/. . .	Crystals—Units (Quantities and frequencies as required by W/T. organisation.)			
10H/10969	Plug type 118	1		2 pole shorted for ground testing.
5C/543	Switchbox, type B, 1 unit	1		
10E/7607	Valve V.R. 18	2	V ₄ , V ₅	R/F. amplifier
10E/7738	Valve V.R. 21	2	V ₇ , V ₈	A/F. amplifier
10E/7958	Valve V.R. 22	1	V ₉	Receiver output
10E/8239	Valve V.R. 27	1	V ₆	Detector
10E/10945	Valve V.T. 50	1	V ₁	Oscillator
10E/10946	Valve V.T. 51	2	V ₃ , V ₂	Modulator and R/F. power amplifier.
10A/10989	Microphone, type 19, consisting of :—			
10A/10990	Microphone, type 18	1		Electro-magnetic
10H/10353	Cord, instrument, type Q	1		
10H/10991	Plug, type 119	1		
	Remote controls	—		See Appendix of A.P.1186, Sect. 2, Chap. 2.

APPENDIX II

TRANSMITTER-RECEIVERS TR9D, TR9F, TR9G, TR9H, TR9J, TR9K and TR9L

FACILITIES AND PRIMARY USES

1. The information contained in the following tables summarises the facilities provided by each of the above quoted Transmitter-receivers and should be of assistance in discriminating between their various applications.

2. Where the Power Unit, type 173, is used in conjunction with the transmitter-receivers, type TR9H, TR9J or TR9K, a double pole ON/OFF switch, type 894 (Stores Ref. 10F/13236), is used in place of the single pole ON/OFF switchbox, type B, shown on Drg. No. A.P.1186/A.167/42, sheet 2.

3. In cases where the abbreviation E.R.S. (electrical remote switching) appears, the relays normally used for switching from "Normal" to "Special" frequency are employed to effect the remote control. Otherwise M.R.C. (mechanical remote control) is used.

Transmitter-Receiver Type	Comprising		Variant of	Additional Facilities provided	Operating Frequency	Method of Control	Primary Use
	Receiver Unit	Transmitter Unit					
TR9D (10D/10470)	R1120 (10D/10472)	T1119 (10D/10471)	—	Nil	Normal and Special	MRC	Single-seater A/C
TR9F (10D/11740)	R1139 (10D/9175)	T1138 (10D/11741)	—	Nil	Normal and Special	MRC	Multi-seater A/C
TR9G (10D/13316)	R1395 (10D/13318)	T1394 (10D/13317)	TR9D	(i) I/C between all members of crew in multi-seater A/C (ii) I/C on "SEND" "Normal" and "RECEIVE" (iii) I/C on SEND "Special" without modulation of carrier wave (iv) I/C without interference from R D F equipment in same A/C	Normal and Special	MRC	Night Fighters (possible application to Naval Fighter A/C)
TR9H (10D/13319)	R1139 (10D/17742)	T1396 (10D/13320)	TR9F	Electrical remote switching of ON/OFF and SEND/RECEIVE	Normal	ERS	Bomber A/C Normal replacement of TR9F
TR9J (10D/13321)	R1398 (10D/13323)	T1397 (10D/13322)	TR9F	(i) ERS of ON/OFF and SEND/RECEIVE (ii) Operation on 2410 kc/s only	2410 Kc/s	ERS	Coastal Command A/C
TR9K (10D/13324)	R1400 (10D/13326)	T1399 (10D/13325)	TR9F	(i) ERS of ON/OFF and SEND/RECEIVE (ii) Transmitter modulation and i/c without a separate amplifier (A1134)	Normal	ERS	Small gliders and A/C where no A1134 is fitted

AIR MINISTRY

June, 1943

This is A.L. No. 56 to A.P.1186, Vol. I, and concerns Sect. 2, Chap. 4
On "Contents List" below "Nomenclature of Parts Appendix"
add "TR9D, TR9F, TR9G, TR9H, TR9J, TR9K and TR9L—Facilities
and primary uses Appendix II," insert the attached Appendix
II after existing Appendix and make an entry on the Amendment Record
Sheet.

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Transmitter Receiver Type	Comprising		Variant of	Additional Facilities provided	Operating Frequency	Method of Control	Primary Use
	Receiver Unit	Transmitter Unit					
TR9L (10D/13327)	R1402 (10D/13329)	T1401 (10D/13328)	TR9F	(i) ERS of ON/ OFF and SEND /RECEIVE (ii) Operation on 2410 Kc/s only (iii) Transmitter modulation and i/c without A1134 (iv) Additional 60 volts H.T. sup- ply to trans- mitter	2410 Kc/s	ERS	Marine craft of Air/Sea Rescue Service

**CONCISE DETAILS OF
TRANSMITTER-RECEIVER, TYPE T.R.9D**

PURPOSE OF EQUIPMENT	Air-borne transmitter-receiver for single seater aircraft		
TYPE OF WAVE	R/T		
FREQUENCY RANGE	4.3 Mc/s to 6.6 Mc/s.		
FREQUENCY STABILITY	Quartz crystal controlled		
CRYSTAL MULT. FACTOR	Fundamental		
PERCENTAGE MODULATION	90 per cent		
MAXIMUM SENSITIVITY	5 milli-watts output into 20,000 ohm load with 10 micro-volts input at 400 cycles modulated 25 per cent.		
SELECTIVITY			
OUTPUT IMPEDANCE	20,000 ohm, receiver; variable for transmitter		
AMPLIFIER CLASS	Transmitter, Class C; Receiver, Class A		
MICROPHONE TYPE	Carbon or electro-magnetic		
VALVES	<i>Transmitter, T.1119</i> Oscillator, V.T.50 (Stores Ref. 10E/10945) Modulator, V.T.51 (Stores Ref. 10E/10946) Power-amplifier, V.T.51 (Stores Ref. 10E/10946) <i>Receiver, R. 1120</i> R/F (2) V.R.18 (Stores Ref. 10E/7607) Detector, V.R.27 (Stores Ref. 10E/8239) A/F amplifier (2), V.R.21 (Stores Ref. 10E/7738) Power amplifier, V.R.22 (Stores Ref. 10E/7958)		
POWER INPUT	28 mA. at 120 volts, H.T. Transmitter L.T. 0.5 amp. at 2 volts Receiver L.T. 0.9 amp. at 2 volts Total operating current, including relays and microphones, 1.6 amp.		
POWER OUTPUT	0.27 amp. to 0.29 amp. into average aircraft aerial		
STORES REF. NO.	10D/10470		
APPROXIMATE OVERALL DIMENSIONS	LENGTH 19½ in.	WIDTH 13¼ in.	HEIGHT 9½ in.
WEIGHT	Excluding batteries 28 lb. With valves and dry batteries, 40 lb. With remote control equipment, 67 lb.		
ASSOCIATED EQUIPMENT	Remote control, type C or D (Stores Ref. 10J/8186 and 10J/8907) Accumulators, 2 v., 20 Ah (Stores Ref. 5A/1387) Battery, dry, 120 v. (Stores Ref. 5A/1333 or Stores Ref. 5A/1615). Battery, dry, 15 v. (Stores Ref. 5A/1338) Battery, dry, 4½ v. (Stores Ref. 5A/1383) Crystal monitor or R.T. Tester, unit A (modified) (Stores Ref. 10S/7185) or R.T. Tester, Type 1, Unit C (Stores Ref. 10S/35)		

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SECTION 2, CHAPTER 5

TRANSMITTER-RECEIVER T.R.9F

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(Stores Ref. 10D/11740)

INTRODUCTION

1. The transmitter-receiver T.R.9F is designed for use in multi-seater aeroplanes and should not be used without an amplifier, type A.1134. It affords facilities for modulated transmission on either of two "spot" frequencies which may be selected at will. Provision is also made for inter-communication on both SEND and RECEIVE and for reception at six or seven positions in the aeroplane. Remote control operation may be employed.

2. The transmitter-receiver operates over a frequency range of approximately 6.6 Mc/s to 4.3 Mc/s. Stabilization of frequency is determined by fundamentally-operated quartz crystals and two such controlling elements are incorporated in the instrument.

3. The T.R.9F consists of the transmitter T.1138 and the receiver R.1139 fitted into a single crate. The general appearance of the T.R.9F is shown in fig. 1. The T.1138 is specifically intended for use with the electro-magnetic microphone, type 19, in conjunction with the inter-communication amplifier A.1134. A detailed description of the A.1134 will be found in Sect. 4, Chap. 2 of this

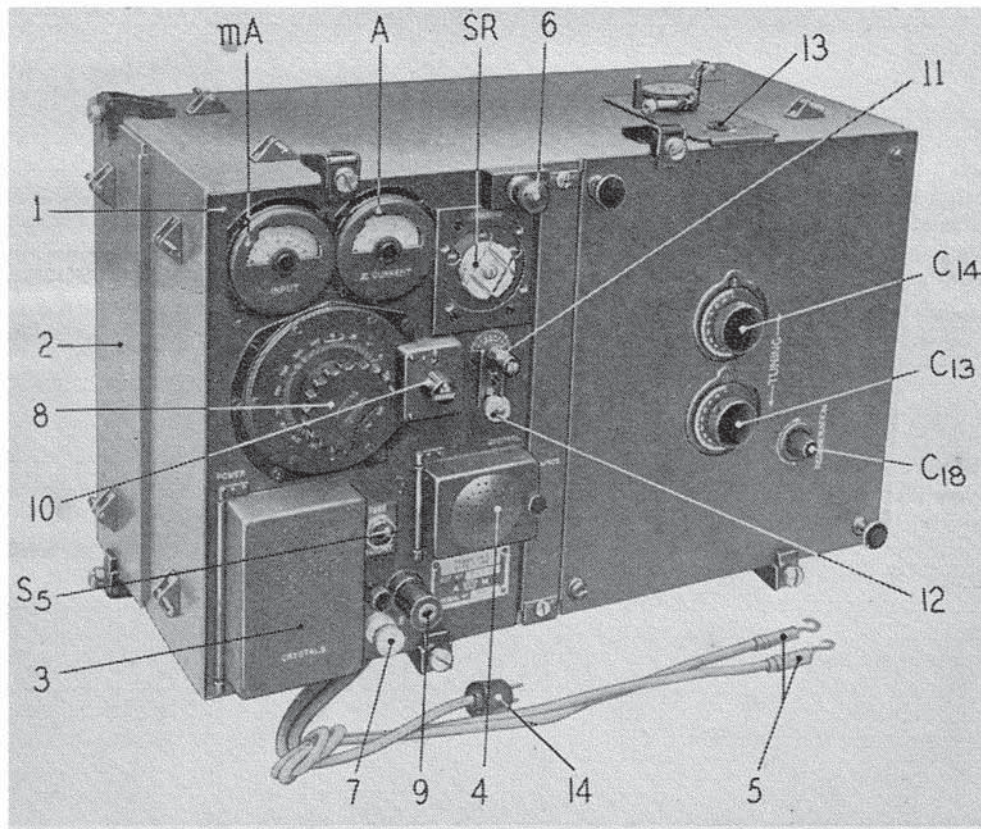


FIG. 1.—THE TRANSMITTER-RECEIVER T.R. 9F.

publication. The transmitter T.1119 which formed part of the T.R.9D, described elsewhere in this publication, also employed the electro-magnetic type of microphone. The essential difference, therefore, between the two transmitter-receivers lies in the circuit rearrangement involved to accommodate the amplifier A.1134. The T.R.9F is battery-operated and both the transmitter and the receiver (*one* frequency only) are pre-tuned prior to flight. The A.1134 uses separate batteries.

4. Having regard to the slight circuit differences between the T.R.9F and that of the T.R.9D, it is not intended to recapitulate either the technical or the operational features which can be found in the chapter on the T.R.9D. Some slight duplication is unavoidable but, in the main, reference should be made to the chapter on the T.R.9D for relevant information.

5. The T.R.9F cannot be used without the A.1134 or equivalent amplifying device to afford the essential microphone gain. Due to the absence of adequate supplies both of the A.1134 and of the microphone, type 19, an "interim" form of the T.R.9F has been evolved for use with carbon granule microphones (*see* paras. 41-44). Reference is also made in this chapter (*see* paras. 45-47) to a modification of the T.R.9F designed for use with a high-impedance H.T. source such as a vibrator unit.

GENERAL DESCRIPTION

6. The transmitter-receiver T.R.9F consists of the transmitter T.1138 and the receiver R.1139. A theoretical circuit diagram of the instrument is given in fig. 2. Briefly, the transmitter T.1138 consists of a crystal-controlled oscillator triode V_1 , capacitance-coupled to a radio-frequency amplifying pentode V_2 operated in the Class C condition. The valve V_1 oscillates at one of the two frequencies, NORMAL or SPECIAL, as determined by the fundamental of a quartz crystal selected by switches S_1 or S_2 . The action of S_1 and S_2 is controlled by a Relay₁ which, acting in conjunction with a second relay provides for the simultaneous selection ofappings, appropriate to the frequencies desired, on an aerial inductance L_3 .

7. The modulation of the T.1138 is effected by the familiar choke-control system, an iron-cored choke L_5 being in series with the anodes of V_3 and V_2 . The audio-frequency voltages from the electro-magnetic microphones are amplified by means of the A.1134, a separate battery-actuated instrument consisting of two transformer-coupled A/F stages comprising one Class A voltage amplifier triode and one Class B (quiescent push-pull) power amplifier twin-pentode. The modulating output from the A.1134 is transferred to a step-down transformer T_1 which provides for the lesser degree of excitation, that is, compared with the inter-communication output, suitable for the control-grid circuit of a pentode valve V_3 . The output from the anode of V_3 modulates the R/F carrier.

8. When electro-magnetic microphones were employed with the T.R.9D the voice voltages from them were applied, *via* a transformer, to the audio-frequency stages of the receiver R.1120 which formed part of that transmitter-receiver. The output from the final stage of the R.1120 was then one of three forms, namely, inter-communication, received signals, or modulating voltages for transfer to the stage V_3 of the transmitter portion. With the T.R.9F and its sub-modulator A.1134 the necessity for the inter-communication and modulating function of the associated receiver A/F stages disappears. The connexion which existed between the final stage of the receiver and the modulating stage of the transmitter is no longer needed but a junction is necessary to provide for the receiver independent H.T. supply. The I/C and telephone circuits now lead externally to the A.1134 and not internally to the transformers T_2 and T_1 .

CONSTRUCTIONAL DETAILS

9. The only constructional details illustration of the transmitter T.1138 and the receiver R.1139 shown herein to supplement the illustrations given in the chapter in the T.R.9D is that of fig. 1 which shows the general appearance of the instrument. Bench wiring diagrams of the T.1138 and the R.1139 are given in figs. 3 and 4. The annotational references of fig. 2 have been preserved throughout.

10. Referring to figs. 3 and 4 and comparing them with the corresponding bench-wiring diagrams for the T.R.9D, it will be seen that the leads to the spills I/C and EXT. & REC. TELS on the contact bar have been removed and are now joined together. The lead from the top spill on the relay switch nearer to the oscillator valve has been removed and the remaining two spills have been short-circuited by a wire link. The lead to the spill H.T. + I/C has been removed on the receiver side only and connected to the REC. H.T. + spill.

VALVES AND BATTERIES

11. With the exception of the power amplifier V_3 , which is a valve, type VR.118, the valves used in the T.R.9F are identical with those of the T.R.9D. The valve V_3 is biased at 3 volts. The batteries are also as specified for the T.R.9D. The amplifier A.1134 uses separate L.T. and H.T. supplies and therefore does not constitute an additional drain upon the transmitter-receiver power supply. As a precautionary measure, even when using the 20 Ah. 2-volt accumulator, this should be changed after *every* flight of approximately full duration. Subject to certain circuit modifications the T.R.9F may be used with a high impedance H.T. source such as a vibrator unit.

INSTALLATION

12. A typical installation diagram is given in fig. 5. The A.1134 has independent battery supplies when used with the T.R.9F. The amplifier should be installed in such a position that the necessary manipulation of plugs, sockets and key switch can be conveniently performed by the W/T operator.

13. All microphone wiring must be carried out in screened twin-core wire the screen being bonded across wherever a break is made at the terminal points and all screens are earthed. The earth connexion of the A.1134 must be joined to the aeroplane earth or some point connected to it and this may be effected *via* the earth of the T.R.9F. The microphone negative must not be earthed when the A.1134 is used.

PRECAUTIONS AND MAINTENANCE

14. The elementary precautions associated with the use of crystal units and the restrictions imposed relative to the dismantling or repairing of them apply to this transmitter-receiver. Care should be taken to insert the correct frequency crystal, as indicated by the reference number, in the appropriate socket N or S.

15. The L.T. accumulators, both of the T.R.9F and the amplifier A.1134 should be recharged after each flight of approximately full duration and the H.T. battery voltage should be tested at the same time. Renewal of the T.R.9F H.T. battery should be made if the voltage on load falls below 110 volts. The H.T. battery of the amplifier A.1134 must be replaced if it has fallen to 100 volts. The correct values for grid-bias voltage are:—the T.R.9F transmitter modulator stage, 10.5 volt negative, the A.1134, 3 volts negative on the primary stage, and 6 volts negative on the output stage.

16. A slight chirp will be heard when the amplifier A.1134 is switched either on or off. This is a transient effect due to the warming-up of the valves and is quite normal. For other relevant notes on precautions and maintenance, reference should be made to the appropriate chapters, namely those on the T.R.9D and the amplifier A.1134, in this publication.

OPERATION

17. The transmitter portion of the T.R.9F is crystal-controlled and is, in consequence, not dependent upon an outside monitor for the frequency determination of its emitted carrier. The service standard type of crystal holder is utilized. An illustration of the T.R.9F showing the front panel controls is given in fig. 1.

Transmitter T.1138

18. The T.R.9F is pre-tuned prior to flight. The transmitter T.1138 *must* be tuned before the receiver R.1139. The procedure to be followed is set out below. Remove the transmitter (1) from the transit case and insert a 120-volt H.T. battery and a 15-volt grid-bias battery in the battery tray (2), connecting the appropriate plugs. Set the grid bias to 10.5 volts negative.

19. Switch OFF the SEND-RECEIVE switch SR and, if fitted, (*see* paras. 33–36) the switch S_5 should be at TUNE. Insert the valve V_1 and replace the transmitter in the transit case. Plug the appropriate crystal into the NORMAL socket, labelled N. Access to the crystal holder and to the holder for the valve V_2 is through the door (3) at the bottom left-hand corner of the instrument. Insert the valves V_2 and V_3 in position. The holder for V_3 will be found inside the smaller door (4). Connect the L.T. leads (5) to the 2-volt accumulator. The tumbler switch, type B, single unit, in the pilot's cockpit should be turned to NORMAL. Connect the aerial (6) and the earth (7) terminals to the appropriate leads. Plug in the Remote Volume control (13) and microphone/telephone lines (14) by means of the plugs and sockets provided.

20. Switch SR to SEND and S_6 to TRANSMIT. Tune by means of the aerial inductance control (8) until the aerial current as read on the ammeter A rises to a maximum. The total anode current on SEND will be in the region of 25 milliamperes. Modulation may now be checked by connecting the amplifier A.1134 to the transmitter and shouting into the electro-magnetic microphone. There should be, approximately, an aerial current increase of 30 per cent.

21. The procedure for tuning the transmitter to the SPECIAL frequency is as follows:—Insert the appropriate crystal into the S position and place SR at SEND. The tumbler switch in the cockpit should be turned to SPECIAL. Alternatively, the two-pole socket (9) can be short-circuited with a length of wire. The switch S_6 , if fitted, is turned to TUNE and the control (10) engraved SAE COARSE is adjusted, in conjunction with that (11) marked SAE FINE, until the aerial current as read on A gives a maximum reading (probably about 0.12 amp.). If two settings of SAE FINE are obtained that which gives the lower reading on the ammeter A should be used. The transmitter is then tuned to the SPECIAL frequency and modulation may be tested as for the NORMAL frequency. It may be found necessary, on turning back to the NORMAL, to make some slight adjustment of the control (8) of L_3 . The transmitter is now set up on the two frequencies, the one to be transmitted when the pilot's switch is NORMAL and the other when the switch is SPECIAL, both being modulated. Turn S_6 , if fitted, to TRANSMIT and the aerial and input currents should rise to the values specified in the table below. Modulation applied should give an approximate rise in aerial current of 30 per cent.

22. For the purpose of bench tuning an artificial aerial, type 3, or a $100\mu\text{F}$ condenser, type M may be substituted for the aerial and earth. The capacitance of the artificial aerial should be set to $100\mu\text{F}$. The following table may be used as a guide for preliminary settings. It should be noted that the figures given are applicable to the T.R.9F proper.

Crystal frequency Mc/s	Crystal in Socket	Tumbler switch in pilot's cockpit	NORMAL aerial tuning		SPECIAL aerial tuning		Input mA	Output amperes A
			Turns	Degrees	SAE COARSE	SAE FINE		
6.66	N	OFF	5	350			24	0.23
5.50	N	OFF	9	4			24	0.23
4.25	N	OFF	13	200			24	0.23
6.66	S	ON			4	20	25	0.22
5.50	S	ON			6	8	25	0.22
4.25	S	ON			10	5.5	25	0.22

Receiver R.1139

23. Before setting up the R.1139 it is of primary importance to realize that the volume control affects the tuning and that, in consequence, the receiver should always be set up with the volume control at MAXIMUM. It is essential that the instrument should be monitored to an initially weak signal. An endeavour to set up the receiver on any strong signal, as for example, the signal from a T.1087 at about 500 yards distant and with the volume control set to obviate "swamping", is a sure cause of operational failure.

24. The transmitter T.1138 MUST be tuned before the receiver R.1139. The aerial circuit of the transmitter constitutes the input circuit to the grid of the receiver first H.F. valve so the receiver aerial circuit is already tuned before setting-up takes place.

To set up the receiver with R/T tester, crystal monitor or wavemeter

25. It is useless to set up the R.1139 on any transmission which has not been crystal monitored or referred to a similar standard. If a crystal monitor or wavemeter is used it must be capable of producing a modulated signal. Information on the incorporation of a crystal in the wavemeter, type W.39, or in R/T testers can be found elsewhere in this publication. Preferably the receiver should be set up by the use of the crystal-controlled R/T Tester, type 1, Unit A. Either the crystal from the T.R.9F or one of identical frequency should be used. The tester should be taken inside the aeroplane and placed conveniently close to the T.R.9F. The required degree of attenuation of the tester signal can be obtained by closing the lid which affords effective screening. The emitted signal can be reduced to R1 strength at a maximum gain.

26. Insert the receiver valves and connect the grid-bias battery. The grid-bias voltage for V_7 and V_8 is 1.5 volts and for V_9 , 3 volts. Switch off SR before inserting the valves or opening the case. Place the pilot's fine tuning control to its central position. Then switch on the R/T Tester.

27. Rotate the controls of C_{13} and C_{14} , keeping them approximately numerically in step, until a signal is audible. The control of the regeneration condenser C_{18} will probably need adjustment. If the receiver breaks into violent oscillation unscrew the regeneration control until just beyond the point of oscillation and re-tune. The reception of the signal at its best will probably be a matter of trial and error and the R/T Tester lid will be adjusted accordingly. On no account should either volume control or fine tuning control be altered at this stage.

28. When, by adjustment of the tuning and regeneration controls, the receiver is satisfactorily tuned, the regeneration control should be turned back sufficiently to ensure that oscillation does not occur over the entire range of the fine tuning control and the controls of C_{13} and C_{14} readjusted slightly to give maximum strength. The regeneration control must not be moved again.

To set up the receiver with another T.R.9F

29. In default of a proper monitor and providing an instrument can be spared, a T.R.9F should be installed in a ground station for setting up aeroplane receivers. When so used a condenser of about $0.0001\mu\text{F}$ should be fixed across the aerial and the earth. During the setting-up, modulation may be obtained by inserting a condenser of $0.001\mu\text{F}$ between the Mic+ and Tel+ contacts.

To set up the receiver with no source of transmission

30. If no source of transmission whatever is available, initial setting-up of R.1139 can be effected but the method demands quiet conditions and some practice. Having first tuned the transmitter so that the aerial circuit is set to the required frequency, place the receiver volume

control to MAXIMUM and the fine tuning to the central position. Turn the regeneration control to a position just off oscillation point. Then slowly adjust C_{13} and C_{14} , keeping them in step, until the "mush" background of R.1139 rises to a maximum intensity. As the true tuning is determined by the aerial circuit of the transmitter the aerial inductance control (8, fig. 1) should be rotated to discover whether the intensity increases. If so C_{13} and C_{14} must be readjusted. The two H/F circuits are then tuned to the same frequency as the aerial circuit. It is important that the regeneration control should be set just below oscillation point, a condition which imposes constant readjustment whilst searching. When tuning has been completed it is desirable to turn back the regeneration control one turn.

Operation in the air

31. Normally the pilot has control of the SEND-RECEIVE switch, fine tuning and volume control, which are all mounted together in the controller type C. The tumbler switch which selects one of the two transmitter frequency bands, N or S, is also at this position.

32. When the receiver is used on one frequency only, the fine tuning handle on the controller should not need adjustment as the receiver tuning is determined by the transmitter circuit. A change from one receiver frequency to another can only be made if the receiver is pre-tuned to *both* frequencies and the settings determined and recorded. Such a change would necessitate an adjustment of the fine tuning handle after the new frequency settings had been made.

AUXILIARY "SEND-RECEIVE" REMOTE CONTROL

33. Where it would be inconvenient to fit a manual control, a quick-action auxiliary remote control of the SEND-RECEIVE switching of the T.R.9F is provided in some installations but at one point only. This modification is described in Leaflet A.109 of A.P.1186, Vol. II, Pt. 1. Transmitter—receivers so modified are labelled on the crystal cover (3, fig. 1).

The switch, type 220

34. The auxiliary control is in the form of a small two-way plunger switch, type 220, connected to the T.R.9F by a flexible metal-braided lead and operated by the member of the crew taking SEND-RECEIVE control.

35. The modification entails the bringing out of three leads, H.T. positive supply and the transmitter and receiver H.T. positive feeder lines, *via* a socket, type 46 to a two-way plunger switch, type 220. The socket type 46 replaces the TUNE-TRANSMIT switch S_5 , type 77. The L.T. battery is connected to both T.1138 and R.1139 when the manual SEND-RECEIVE switch is placed at either SEND or RECEIVE. With the pilot's control in the RECEIVE position, the H.T. positive is connected to the receiver H.T. positive by means of two spring-loaded contacts in the switch, type 220. On pressing the plunger the H.T. positive is switched from the receiver to the transmitter. If the extension lead plug, type 77, is removed from the T.1138, the spring contacts in the socket, type 46, restore the normal circuit. The modification is shown in fig. 3.

Operation

36. In installations where this auxiliary control is fitted, the manual control may be used in the normal way. To bring the auxiliary control into operation place the manual control to RECEIVE. The manual control must remain in this position whilst the auxiliary is being operated. To change from RECEIVE to TRANSMIT press the switch, type 220. The manual controller has, at all times, master control of switching to TRANSMIT. To switch off the T.R.9F place the manual control switch to the OFF position.

AERIAL MATCHING UNIT, TYPE 9

(Stores Ref. 10A/12025)

37. An aerial matching unit, type 9, has been introduced for use with the T.R.9F to afford effective matching in the case of an aerial system in which the combined length, in feet, of the aerial and earth leads exceeds a value determined by the formula $\frac{200}{f}$, where f equals the operation frequency expressed in megacycles. As an example, the unit should be used for 5.0 megacycles transmission with an aerial system exceeding 40 feet.

38. The aerial matching unit, type 9, consists of a variable condenser of $0.003\mu\text{F}$ maximum capacitance contained in a well-insulated box. It is mounted close to the aerial terminal of the T.R.9F and is inserted in series with the aerial. Full details will be found in A.P.1186, Vol. II, Pt. 1.

39. To adjust the unit, the SPECIAL frequency should always be tuned first. Set the SPECIAL frequency fine-tuning condenser S.AE FINE (11, fig. 1) to zero degrees and lock in position by means of the knurled locking screw (12). Tune the transmitter to SPECIAL frequency by adjusting the

aerial inductance control (8), using the condenser of the aerial matching unit, type 9, as a fine tuning control. Due to the possibility of obtaining several different LC combinations with this unit in circuit, the optimum reading on the ammeter A can only be determined by trial and error. When the best position is obtained lock the condenser.

40. To tune for the NORMAL frequency use the inductance control (8) only, leaving the matching unit condenser locked in the position arrived at for the SPECIAL tuning. The adjustments for the SPECIAL and NORMAL frequencies are slightly interdependent and it may be necessary to repeat the above sequence of operation for final adjustment.

THE MODIFIED (INTERIM) T.R.9F

41. Reference has been made in this chapter to the "interim" (carbon microphone) T.R.9F evolved for use pending supplies of the A.1134 and the electro-magnetic microphones, type 19. Precise instructions for the modifications necessary are given in Leaflet A.99 of A.P.1186, Vol. II, Part 1.

42. The principal alterations required are to ensure that I/C is obtainable on both SEND and RECEIVE, that modulation is effected on both frequencies, that the transformer T_1 is connected to the output of R.1139 to utilize the amplification of the audio-frequency stages and that the output valve of R.1139 is changed from a V.R.22 to a V.R.118 tetrode (biased to 3 volts negative).

43. The short-circuiting link A across the $30\mu\text{F}$ condenser C_{31} is removed and the $0.002\mu\text{F}$ condenser C_{32} is short-circuited. A resistance of 250 ohms is connected across the microphone circuit to maintain a minimum load in this circuit. This resistance is connected between the contact on SR_4 which joins to the MIC+ contact and the Earth terminal on the side of the chassis.

44. The same general principles of setting-up, pre-tuning and operation of the transmitter and the receiver apply as for the T.R.9F. In both SEND and RECEIVE positions the L.T. is "made" to all valves so it is advisable to have a stand-by 2-volt accumulator. A careful watch should be kept on the state of the H.T. battery, which must not be permitted to fall below 110 volts on load. Grid-bias batteries should also be periodically checked.

THE T.R.9F MODIFIED FOR USE WITH VIBRATOR UNIT

45. When the T.R.9F is used with a H.T. source of high impedance nature, such as a vibrator unit, certain modifications are necessary to provide stability. These modifications are fully described in the Leaflet A.125 of A.P.1186, Vol. II, Part 1 and entail the fitting of a R/F filter between the detector valve V_6 and the first A/F valve V_7 , the decoupling of the first A/F stage and the provision of a permanent load across the primary of the microphone transformer to prevent instability when the microphones are open-circuited.

46. The resistance of 250 ohms to which reference was made in para. 43 is retained in circuit. The resistance R_{17} (fig. 2) is replaced by one of 50,000 ohms; a 20,000 ohm resistance is inserted between R_{17} and R_{21} and a 250,000 ohm resistance is connected between the anode of V_6 and R_{15} . A $50\mu\text{F}$ condenser is inserted between the high potential end of the 250,000 ohm resistance and earth. A $0.5\mu\text{F}$ condenser is placed between R_{17} and earth.

47. When setting-up, or operating, the T.R.9F so modified, it is essential that the precaution is taken to maintain at least *two* pairs of telephones in the receiver output.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this transmitter-receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/11740	Transmitter-receiver T.R.9F			
	Comprising:—			
10D/11500	Amplifier A.1134	1		See A.P.1186, Vol. I, Sect. 4, Chap. 2
10D/11743	Case	1		Fitted with:— 10A/10477, Bar, contact leads and 10H/7383, Plug, type 48
10A/10477	Bar, contact	1		
10A/9172	Cover, contact case	1		
10D/11741	Transmitter, type T.1138	1		For details see below
10D/11742	Tray, battery	1		
10A/9175	Receiver, type R.1139	1		For details see below
	Transmitter, type T.1138			
	Principal components:—			
10A/7818	Ammeter, thermo 0—0.5	1	A	
10A/10474	Bar, contact, type 8	1		
10H/9227	Base, terminal	1		
	Choke,			
10C/9206	H/F, type 34	1	L ₂	
10C/10117	H/F, type 37	1	L ₄	
10C/7912	L/F, type G	1	L ₅	
10D/10473	Coil, aerial	1	L ₃	
	Condenser,			
10C/8009	Type 132	1	C ₃	0.0005 μ F
10C/9179	Type 280	1	C ₅	0.001 μ F
10C/9185	Type 286	1	C ₄	0.01 μ F
10C/9208	Type 289	1	C ₇	0.002 μ F
10C/10394	Type 404	1	C ₂	10 $\mu\mu$ F
10C/10476	Type 411	2	C ₁ , C ₈	50 $\mu\mu$ F
10F/10111	Head, switch	1		
	Holder,			
10H/10478	Crystal	1		
10H/9615	Valve, type S	2		5-pin for V ₂ and V ₃
10H/10479	Valve, type X	1		4-pin for V ₁
10A/7820	Milliammeter 0—30	1		
	Plate,			
10H/9195	Guard	1	2	For valve holders
10F/10112	Stop	1		
10H/9508	Plug, type 77	1		For aux. R/C
10F/10480	Relay, magnetic, type 42	2	Relay ₁ , Relay ₂	
	Resistance,			
10C/7956	Type 103	1	R ₄	5,000 ohms
10C/8020	Type 112	1	R ₂	30,000 ohms
10C/8021	Type 113	2	R ₁ , R ₃	20,000 ohms
10C/123	Type 591	1		250 ohms (see paras. 43 and 46)
	Socket,			
10H/7276	Type 11	1		
10H/9326	Type 46	1		Replaces S ₅ for aux. R/C
	Switch,			
10F/10113	Type 137	1	SR ₁ , SR ₂ , SR ₃ , SR ₄	
10F/8142	Type 77	1	S ₅	
10A/10497	Transformer, L/F, type 19	1	T ₁	

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver T.R.9F (<i>contd.</i>)			
	Receiver, type R.1139			
	Principal components:—			
10A/10475	Bar, contact	1		
	Base, terminal,			
10H/9190	1-way, type A	1		Engraved 16
10H/9191	2-way	1		Engraved 14, 15
10H/9192	3-way, type A	1		Engraved 1, 2, 3
10H/9224	3-way, type B	1		Engraved 22, 23, 24
10H/9193	5-way, type A	1		Engraved 4, 5, 6, 7, 8
10H/9225	5-way, type B	1		Engraved 9, 10, 11, 12, 13
10H/9226	5-way, type C	1		Engraved 17, 18, 19, 20, 21
10D/9189	Can, coil	3		
	Choke,			
10C/10117	H/F, type 37	1	L ₉	
10C/9384	L/F, type B	1	L ₈	
10D/9187	Coil, anode			
	Condenser,			
10C/7902	Type 121	1	C ₂₂	0.0001 μ F
10C/7906	Type 125	2	C ₁₀ , C ₁₉	0.01 μ F
10C/8388	Type 178	1	C ₃₂	0.0002 μ F
10C/9178	Type 279	1	C ₁₇	0.0003 μ F
10C/9179	Type 280	4	C ₂₄ , C ₂₅ , C ₂₇ , C ₂₈	0.001 μ F
10C/9180	Type 281	1	C ₃₀	2 μ F
10C/9181	Type 282	8	C ₉ , C ₁₅ , C ₁₆ , C ₂₀ , C ₂₃ , C ₂₆ , C ₂₉	
10C/9182	Type 283	1	C ₁₈	Miniature variable
10C/9184	Type 285	1	C ₃₁	30 μ F
10C/9185	Type 286	1	C ₂₁	0.01 μ F
10C/9197	Type 287	1	C ₁₁ , C ₁₂	48 μ F
10C/9198	Type 288	2	C ₁₃ , C ₁₄	0.000233 μ F
10C/10532	Type 421	1		50 μ F (<i>see para. 46</i>)
10C/10554	Type 423	1	C ₃₅	0.1 μ F
10C/10948	Type 429	2	C ₃₃ , C ₃₄	20 μ F
10H/9194	Holder, valve, type R	6		
	Plate,			
10H/9195	Guard	6		For valve holders
10H/9196	Guide	6		For valve holders
	Knob,			
10A/9202	Type 1	2		
10A/9201	Type 2	2		
10H/9176	Plug, type 76	3		Grid-bias battery
	Resistance,			
10C/7955	Type 102	1	R ₁₂	2,000 ohms
10C/7957	Type 104	1	R ₂₄	10,000 ohms
10C/8016	Type 108	2	R ₅ , R ₁₆	0.5 megohm
10C/8017	Type 109	1	R ₁₉	2 megohms
10C/8018	Type 110	2	R ₁₃	0.25 megohms (<i>see para. 46</i>)
10C/8019	Type 111	1	R ₁₅	100,000 ohms
10C/8021	Type 113	5	R ₇ , R ₈ , R ₁₁ , R ₁₄ , R ₁₇	20,000 ohms (<i>see para. 46</i>)
10C/8117	Type 123	4	R ₉ , R ₁₉ , R ₂₀ , R ₂₂	1 megohm
10C/7910	Type 130	2	R ₆ , R ₁₀	1.5 ohms
10C/8519	Type 145	1	R ₂₁	200,000 ohms
10C/11026	Type 400	1		50,000 ohms (<i>see para. 46</i>)
10A/9199	Ring, clamp	1		For R/C attachment
10A/9200	Screw, clamp	1		For 10A/9199
10A/7394	Socket, type 17	1		For R.V.C.
10A/7916	Transformer, type 51	1	T ₂	
10A/9203	Wheel, index	1		For R/C attachment

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver T.R.9F (<i>contd.</i>)			
	Receiver, type R.1139 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Accessories:—			
	Accumulator,			
5A/1386	Type B, 2-V., 14 Ah. or	1		{ According to operational requirements
5A/1387	Type B, 2-V., 20 Ah.	1		
10A/12025	Aerial matching unit, type 9	1		
	Battery,			
5A/1383	*Dry, 4½-V.	1		Receiver grid bias
5A/1338	*Dry, 15-V.	1		Transmitter grid bias
5A/1333	*Dry, 120-V	1		H.T.
	(*or appropriate overseas pattern)			
10D/10993	Case, transit	1		For complete transmitter-receiver
	Contact,			
10A/10984	Type 1	1		12-volt master
	or			
10A/10994	Type 2	1		24-volt master
10A/10985	Type 3	1		12-volt remote
	or			
10A/10995	Type 4	1		12-volt remote
10A/10988	Dummy	1		Fitted with:— 10H/8118, Plug, type 62
10K/ as required	Crystal unit			
10H/10969	Plug, type 118	1		
5C/543	Switchbox, type B, 1 unit	1		
10F/108	Switch, type 220	1		For aux. R/C
	Valve,			
10E/7607	Type V.R.18	2	V ₄ , V ₅	
10E/7738	Type V.R.21	2	V ₇ , V ₈	
10E/8239	Type V.R.27	1	V ₆	
10E/	Type V.R.118	1	V ₉	
10E/10945	Type V.T.50	1	V ₁	
10E/10946	Type V.T.51	2	V ₂ , V ₃	
10A/10989	Microphone, type 19			
	Comprising:—			
10A/10990	Microphone, type 18	1		Electro-magnetic
10H/10353	Cord, instrument, type Q	1		
10H/10991	Plug, type 119	1		

CONCISE DETAILS OF TRANSMITTER-RECEIVER T.R.9F

PURPOSE OF EQUIPMENT	For multi-seater aeroplanes		
TYPE OF WAVE	R/T		
FREQUENCY RANGE	6.6 Mc/s to 4.3 Mc/s		
FREQUENCY STABILITY	Quartz crystal controlled		
CRYSTAL MULT. FACTOR	Fundamental		
PERCENTAGE MODULATION	90 per cent.		
MAXIMUM SENSITIVITY	5 milli-watts output into 20,000 ohms load with 10 microvolts input at 400 cycles modulated 25 per cent.		
SELECTIVITY	—		
OUTPUT IMPEDANCE	Variable-common aerial circuit for transmitter and receiver		
AMPLIFIER CLASS	Transmitter T.1138, Class C		
MICROPHONE TYPE	Electro-magnetic, type 19 with amplifier A.1134		
VALVES	<i>Transmitter T.1138</i> Oscillator, V.T.50 (Stores Ref. 10E/10945) Modulator, V.T.51 (Stores Ref. 10E/10946) Power amplifier, V.T.51 (Stores Ref. 10E/10946) <i>Receiver R.1139</i> R/F (2) V.R.18 (Stores Ref. 10E/7607) Detector, V.R.27 (Stores Ref. 10E/8239) A/F amplifier (2). V.R.21 (Stores Ref. 10E/7738) Power amplifier V.R.118 (Stores Ref. 10E/88)		
POWER INPUT	Approximately 24 mA. at 120 volts H.T. Transmitter, L.T. 0.5 amp. at 2 volts. Receiver, L.T. 0.9 amp. at 2 volts. Total operating current, including relays and microphones, 1.6 amp.		
POWER OUTPUT	0.27 amp. to 0.29 amp. into transmitter aerial		
STORES REF. NO.	10D/11740		
APPROXIMATE OVERALL DIMENSIONS	LENGTH 19½ in.	WIDTH 13½ in.	HEIGHT 9½ in.
WEIGHT	Excluding batteries 28 lb. With valves and dry batteries 40 lb. With remote control equipment, 67 lb.		
ASSOCIATED EQUIPMENT	Amplifier, A.1134 (Stores Ref. 10U/1150) Microphone, type 19 (Stores Ref. 10A/10989) Battery, dry, 120 v. (Stores Ref. 5A/1333 or 5A/1615) Battery, dry, 15 v. (Stores Ref. 5A/1338) Battery, dry, 4½ v. (Stores Ref. 5A/1383) A Crystal monitor or R.T. Tester, type 1, Unit C (Stores Ref. 10S/35) or R.T. Tester, type 1, Unit A (Stores Ref. 10S/7185) modified		

CONDENSERS	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈	C ₉	C ₁₀	C ₁₁	C ₁₂	C ₁₃	C ₁₄	C ₁₅	C ₁₆	C ₁₇	C ₁₈	C ₁₉	C ₂₀	C ₂₁	C ₂₂	C ₂₃	C ₂₄	C ₂₅	C ₂₆	C ₂₇	C ₂₈	C ₂₉	C ₃₀
RESISTANCES	R ₁	R ₂	R ₃	R ₄					R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	R ₁₁	R ₁₂	R ₁₃	R ₁₄	R ₁₅	R ₁₆	R ₁₇	R ₁₈	R ₁₉	R ₂₀	R ₂₁	R ₂₂				
INDUCTANCES																														
MISCELLANEOUS	V ₁ , T ₁	S ₂	S ₁	V ₃	V ₂	S ₃	S ₄	SR ₁ SR ₂ SR ₃ SR ₄	V ₄	V ₅																				

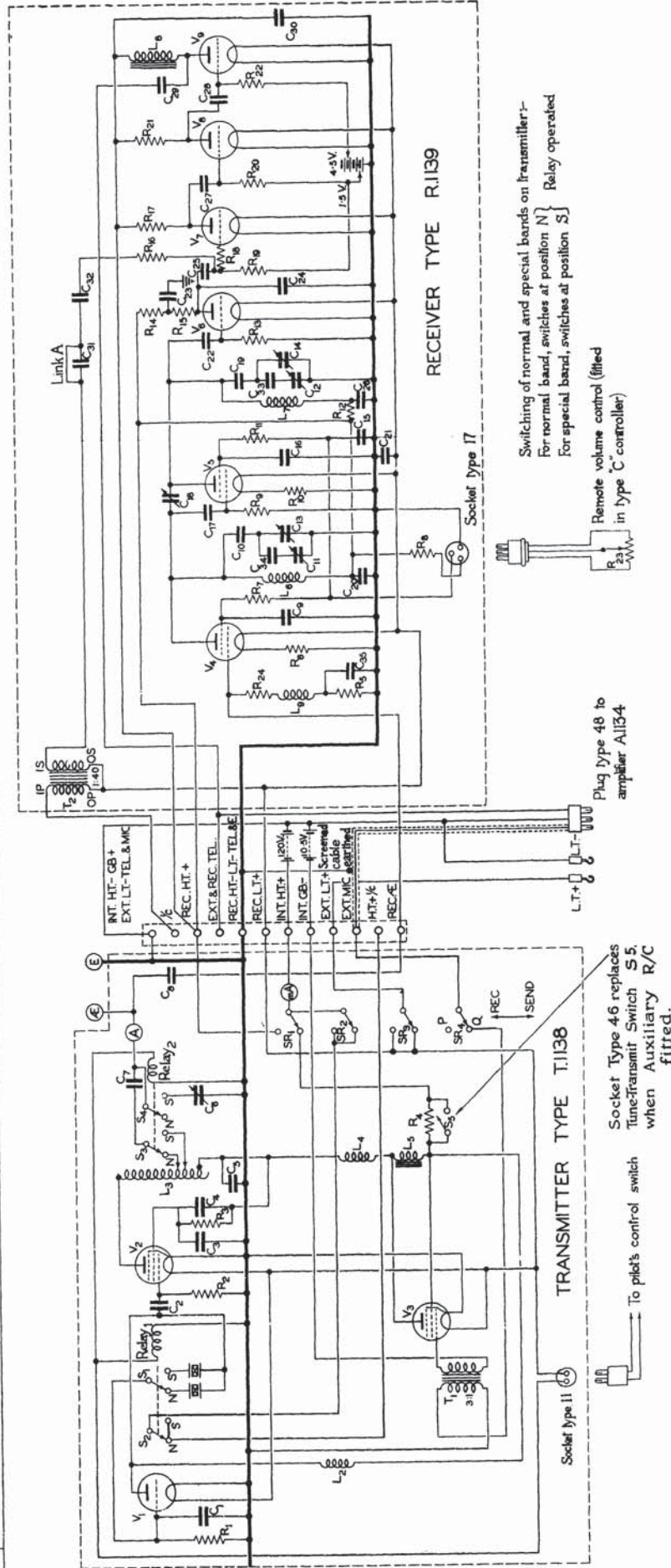


FIG.2. T.R.9.F. THEORETICAL CIRCUIT DIAGRAM

In Installations in which Auxiliary Remote Control is incorporated:-
~~REMOVED LEADS~~ Represents NEW leads ~~REMOVED LEADS~~

FIG.3. BENCH WIRING DIAGRAM OF T.1138.

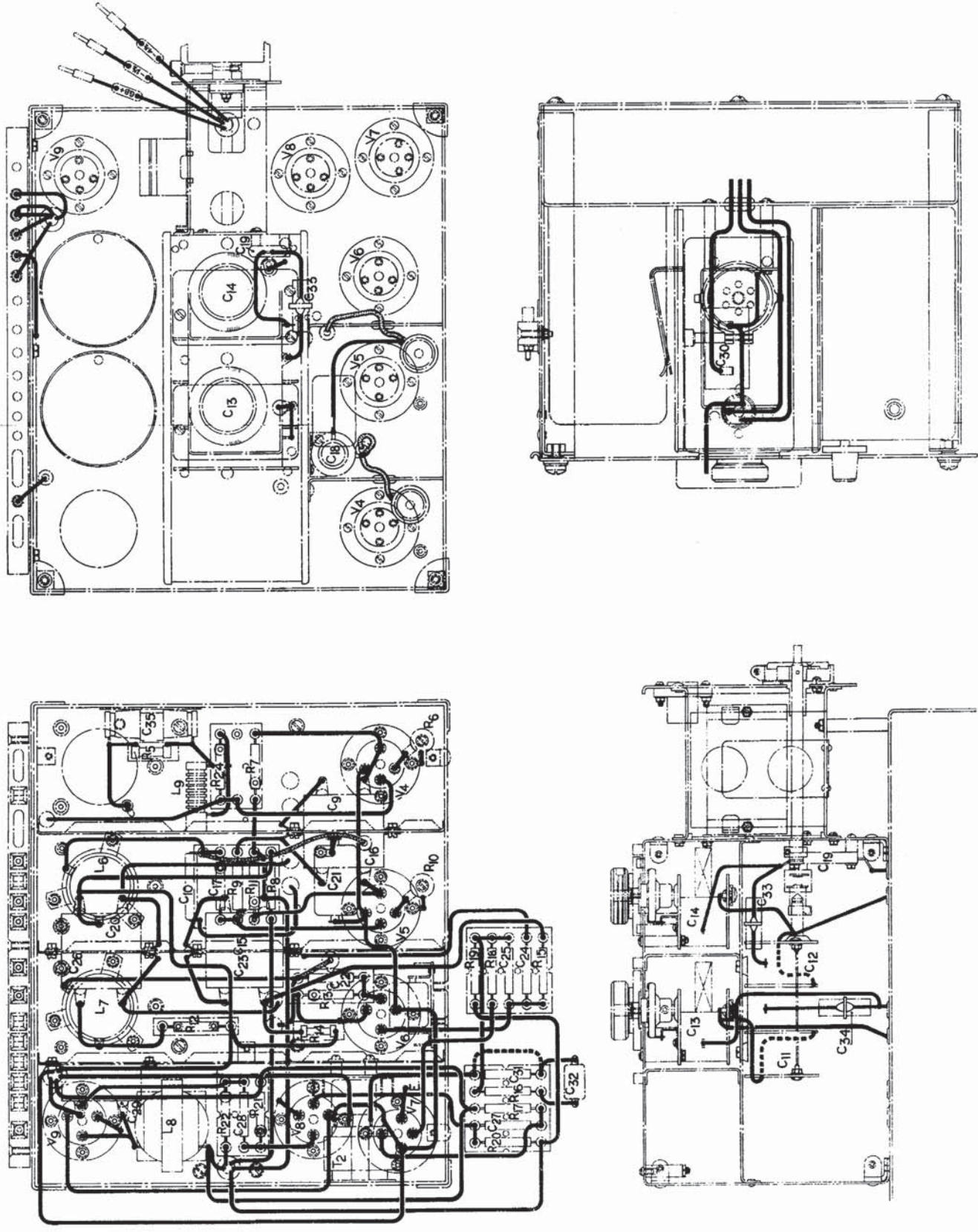


FIG. 4. BENCH WIRING DIAGRAM OF R.139

FIG. 5. T.R. 9F INSTALLATION DIAGRAM

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AIR PUBLICATION 1186

Volume I

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TRANSMITTER-RECEIVER T.R.1148A

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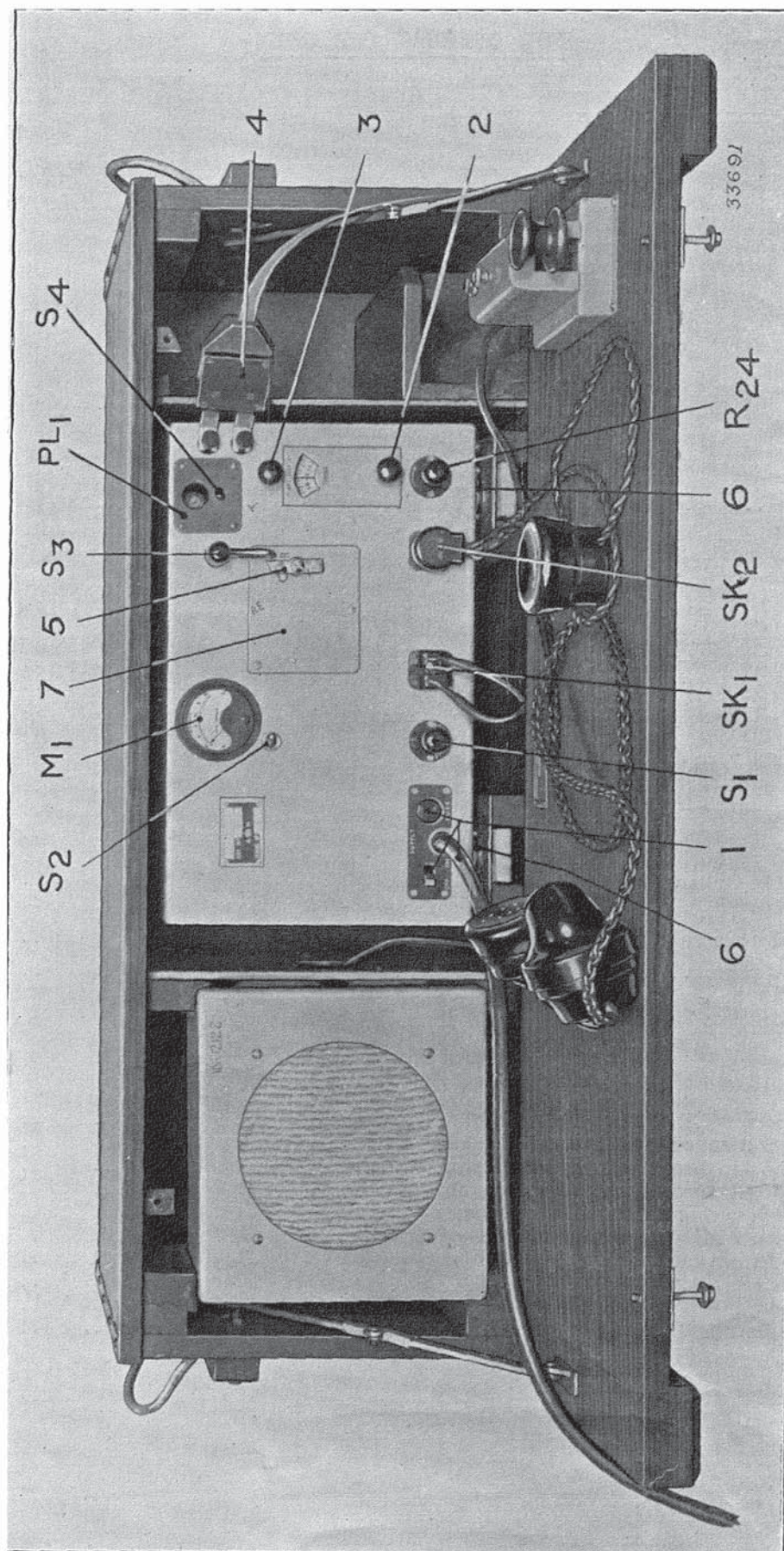


Fig. 1. Transmitter-receiver T.R.1148A.

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AIR MINISTRY
September 1944

A.L. No. 63 to A.P.1186
Volume I

ROYAL AIR FORCE SIGNAL MANUAL, PART IV

Note.—When making the hand-written amendments called for by this Amendment List, write "A.L.63" in the outer margin of the A.P. against each such amendment.

SECTION 6 CHAPTER 6

- (1) On Contents list make the following amendments:—
- (i) Last line, *add* "1" after "Appendix"
 - (ii) After last line, *add*—"Type 10, general description and operating instructions Appendix 2".
- (2) *Re-number* existing Appendix on every page as "Appendix 1"
- (3) *Insert* the attached Appendix 2 after Appendix 1.

When you have done this, make an entry in the Amendment Record Sheet at the ~~back~~ *beginning* of the book.

TRANSMITTER-RECEIVER T.R.1148A

(Stores Ref. 10D/285)

INTRODUCTION

1. This instrument consists of a two-valve transmitter and a three-valve receiver, contained in a single metal case, and covers a frequency range of 60 Mc/s to 65 Mc/s. It is intended for the low power transmission and reception of M.C.W. and telephony over a limited area by shore stations of Balloon Command. The carrier power in the aerial circuit is three to five watts, and under normal conditions, good reception of speech up to a distance of approximately 15 miles can be obtained.

2. A special vertical dipole aerial and mast, together with a wooden transit case, are provided with each instrument. The mast is divided into five sections, and being constructed of metal, acts to a certain extent as a reflector, so that both transmission and reception are partially directional.

3. A telephone handset is provided with each instrument together with an external loudspeaker, which may be plugged into the receiver if desired. Reception by telephone or loudspeaker or both can thus be obtained, the loudspeaker being primarily intended for use as a calling device. The transmitter-receiver and loudspeaker fit into a wooden transit case, from which the equipment can conveniently be operated. Space is also provided for carrying various spare components including valves.

4. The instrument can be operated either from a 6-volt accumulator in conjunction with a power unit, type 41 (Stores Ref. 10K/35) or from A.C. mains with a power unit, type 38 (Stores Ref. 10K/25) and can thus be used as a mobile station or as a fixed station. The two power units are interchangeable, and space is provided inside the metal case to accommodate whichever one may be in use. The power unit, type 38, is designed to work from a mains supply of 110-240 volts, 40-100 cycles.

5. The overall dimensions of the transmitter-receiver are approximately 9 in. by 8½ in. by 15 in. and the weight 44 lb. with either power unit. The dimensions of the wooden transit case housing the instrument and loudspeaker are 36 in. by 12 in. by 13½ in., whilst those of the case for the aerial equipment are 70 in. by 15½ in. by 8 in.

GENERAL DESCRIPTION**Transmitter-receiver**

6. A theoretical circuit diagram is given in fig. 2 and it will be observed that a total of five valves is employed, two in the transmitter and three in the receiver. Two acorn type valves are used in the receiver, since compactness is one of the primary considerations.

7. Referring to the transmitter portion, the aerial feeder inductance L_4 is coupled to the anode of the oscillator valve V_2 via the inductance L_3 , and tuning is effected by means of the variable condenser unit C_{11} , whilst neutralizing is controlled by the small variable condenser C_{10} . A special stabilizing arrangement FS_1 is incorporated, and can be rapidly adjusted to the desired frequency.

8. The oscillator valve is modulated in its anode circuit via the transformer T_2 from the modulator valve V_1 . Transmission of telephony or M.C.W. can be selected by means of the switch S_1 . In the telephony position, the grid of V_1 is connected to the microphone transformer T_1 , whilst in the telegraphy position it is connected to the tone generator circuit consisting of the capacitances C_1 to C_4 and the resistances R_1 to R_5 .

9. When operating on M.C.W., it will be observed that the key short-circuits the tone generator network during the space position. This method of keying has the advantage that when the signal is being received, the characteristic super-regenerative hiss is suppressed during the spacing period, since the carrier continues to be radiated whilst modulation is not taking place.

10. The switch S_2 connects the meter M_1 in the anode circuit of V_1 or V_2 , so that the current of either valve may be measured. A decoupling circuit consisting of the two R.F. chokes L_5 and L_6 and the condensers C_{12} , C_{13} and C_{14} is incorporated in the heater circuit of the two valves.

11. The receiver operates on the super-regenerative principle and consists of one stage of R.F. amplification, a self-quenching detector and a double triode giving a stage of A.F. amplification and output.

12. The first valve V_3 is a R.F. pentode, and has connected to its grid the inductance L_7 via the grid stopper resistance R_{17} , whilst tuning is effected by means of the series-gap condenser arrangement C_{15} . A slight flattening of tuning is introduced by the inclusion of the small capacitance C_{16} across L_7 , which is variably coupled to the aerial inductance L_8 . The anode of V_3 contains a tuned circuit, which consists of the inductance L_{10} and the series-gap condenser unit C_{25} , whilst this arrangement also incorporates a small fixed condenser C_{26} connected across the tuned inductance. The feed to the grid of the succeeding valve V_4 is taken via C_{29} . The two condensers C_{15} and C_{25} are ganged and operated by a single tuning control.

13. The detector valve V_4 is a triode, and its anode circuit can be traced through the inductance L_9 , the resistance R_{20} and the R.F. choke L_{11} , to one end of the primary of the transformer T_3 . The other end of the primary is connected to the variable resistance R_{23} , by means of which the voltage applied to the anode of V_4 can be adjusted. Across the secondary of T_3 is connected the variable resistance R_{24} , which acts as the A.F. gain control, the sliding contact being connected via the grid stopper R_{26} to V_5 . Both V_3 and V_4 are acorn type valves.

14. The valve V_5 is a double triode, one anode being arranged to give a stage of A.F. amplification, whilst the other supplies the output, via the transformer T_4 , to the telephone and loudspeaker sockets SK_2 and SK_1 respectively.

15. The three position transmit-receive switch S_3 , consisting of seven sections S_{3a} to S_{3g} , interchanges the aerial feeders and H.T. positive supply between the transmitter and receiver, and makes and breaks the energizing current lead to the microphone transformer T_1 . It will be seen that when in the "receive" position, as shown, the H.T. supply from pin 2 of the plug P_1 is fed to the receiver by S_{3a} , and the microphone current from pin 3 is disconnected from the primary of the transformer T_1 by means of S_{3b} . Sections S_{3c} and S_{3d} connect the inductance L_8 to the aerial, whilst S_{3e} and S_{3f} short-circuit and earth L_4 . In the "transmit" position, the H.T. supply from pin 2 of the plug P_1 is switched over to the transmitter by means of S_{3a} , and the energizing current for the microphone from pin 3 is connected to the transformer T_1 by one side of S_{3b} , whilst the other side connects pin 1 to pin 2 (see para. 20). Sections S_{3e} and S_{3f} connect the inductance L_4 to the aerial, L_8 being short-circuited and earthed by S_{3c} and S_{3d} . In the position RE (receive economy), the connections made by the switch are the same as those made in the "receive" position, with the exception that S_{3g} switches off the two transmitter valves by breaking the heater supply from pin 4 of P_1 , whilst the three receiver valves still remain in operation.

Power unit, type 41

16. A theoretical circuit diagram of the vibrator unit is given in fig. 3. The unit is driven from a 6-volt accumulator, which also supplies the energizing current for the microphone and the heater current for the valves in the transmitter-receiver. The dropping resistance R_{32} ensures the correct voltage being supplied to the microphone transformer, whilst smoothing is obtained from the choke L_{16} and the electrolytic condenser C_{46} . The fuse F_1 , ON/OFF switch S_5 and R.F. choke L_{12} , together with its associated condensers C_{40} and C_{41} are incorporated in one of the L.T. leads.

17. H.T. is obtained from the vibrators VIB_1 and VIB_2 connected to the transformers T_5 and T_6 , which have their secondaries connected in parallel and deliver 130mA at 265 volts. Smoothing is effected by means of the two chokes L_{14} and L_{15} and the condensers C_{47} to C_{50} . A further filter arrangement consisting of the R.F. choke L_{13} and the condensers C_{42} and C_{43} is inserted in the H.T. positive output.

18. When operating the instrument in a vehicle, either the positive or negative terminal of the accumulator may be earthed, and to allow for this, the positions of the two vibrators and the reversing links can be altered, so that the polarity of the electrolytic condensers is preserved.

Power unit, type 38

19. A theoretical circuit diagram of the A.C. mains unit is given in fig. 4, from which it will be seen that a full-wave rectifying valve V_8 is employed. The primary of the transformer T_7 can be adjusted to a mains input voltage of 110 to 240, whilst a fuse F_2 and an ON/OFF switch S_6 are connected in the mains lead. The secondary consists of three windings which supply the filament current for the rectifier, the heater current for all the valves and the H.T. output, which is smoothed by means of the choke L_{17} and condensers C_{52} and C_{52A} . Current for the microphone is also provided by the unit.

RESISTANCES	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇	R ₈	R ₉	R ₁₀	R ₁₁	R ₁₂	R ₁₃	R ₁₄	R ₁₅	R ₁₆	R ₁₇	R ₁₈	R ₁₉	R ₂₀	R ₂₁	R ₂₂	R ₂₃	R ₂₄	R ₂₅	R ₂₆	R ₂₇	R ₂₈	R ₂₉																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
CONDENSERS	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈	C ₉	C ₁₀	C ₁₁	C ₁₂	C ₁₃	C ₁₄	C ₁₅	C ₁₆	C ₁₇	C ₁₈	C ₁₉	C ₂₀	C ₂₁	C ₂₂	C ₂₃	C ₂₄	C ₂₅	C ₂₆	C ₂₇	C ₂₈	C ₂₉	C ₃₀	C ₃₁	C ₃₂	C ₃₃	C ₃₄	C ₃₅	C ₃₆	C ₃₇	C ₃₈	C ₃₉																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
MISCELLANEOUS	P ₁	S ₁	T ₁	SK ₁	V ₁	FS ₁	M ₁	L ₁	L ₂	L ₃	L ₄	V ₂	L ₅	L ₆	L ₇	L ₈	V ₃	PL ₁	PL ₂	PL ₃	PL ₄	PL ₅	PL ₆	PL ₇	PL ₈	PL ₉	PL ₁₀	PL ₁₁	PL ₁₂	PL ₁₃	PL ₁₄	PL ₁₅	PL ₁₆	PL ₁₇	PL ₁₈	PL ₁₉	PL ₂₀	PL ₂₁	PL ₂₂	PL ₂₃	PL ₂₄	PL ₂₅	PL ₂₆	PL ₂₇	PL ₂₈	PL ₂₉	PL ₃₀	PL ₃₁	PL ₃₂	PL ₃₃	PL ₃₄	PL ₃₅	PL ₃₆	PL ₃₇	PL ₃₈	PL ₃₉	PL ₄₀	PL ₄₁	PL ₄₂	PL ₄₃	PL ₄₄	PL ₄₅	PL ₄₆	PL ₄₇	PL ₄₈	PL ₄₉	PL ₅₀	PL ₅₁	PL ₅₂	PL ₅₃	PL ₅₄	PL ₅₅	PL ₅₆	PL ₅₇	PL ₅₈	PL ₅₉	PL ₆₀	PL ₆₁	PL ₆₂	PL ₆₃	PL ₆₄	PL ₆₅	PL ₆₆	PL ₆₇	PL ₆₈	PL ₆₉	PL ₇₀	PL ₇₁	PL ₇₂	PL ₇₃	PL ₇₄	PL ₇₅	PL ₇₆	PL ₇₇	PL ₇₈	PL ₇₉	PL ₈₀	PL ₈₁	PL ₈₂	PL ₈₃	PL ₈₄	PL ₈₅	PL ₈₆	PL ₈₇	PL ₈₈	PL ₈₉	PL ₉₀	PL ₉₁	PL ₉₂	PL ₉₃	PL ₉₄	PL ₉₅	PL ₉₆	PL ₉₇	PL ₉₈	PL ₉₉	PL ₁₀₀	PL ₁₀₁	PL ₁₀₂	PL ₁₀₃	PL ₁₀₄	PL ₁₀₅	PL ₁₀₆	PL ₁₀₇	PL ₁₀₈	PL ₁₀₉	PL ₁₁₀	PL ₁₁₁	PL ₁₁₂	PL ₁₁₃	PL ₁₁₄	PL ₁₁₅	PL ₁₁₆	PL ₁₁₇	PL ₁₁₈	PL ₁₁₉	PL ₁₂₀	PL ₁₂₁	PL ₁₂₂	PL ₁₂₃	PL ₁₂₄	PL ₁₂₅	PL ₁₂₆	PL ₁₂₇	PL ₁₂₈	PL ₁₂₉	PL ₁₃₀	PL ₁₃₁	PL ₁₃₂	PL ₁₃₃	PL ₁₃₄	PL ₁₃₅	PL ₁₃₆	PL ₁₃₇	PL ₁₃₈	PL ₁₃₉	PL ₁₄₀	PL ₁₄₁	PL ₁₄₂	PL ₁₄₃	PL ₁₄₄	PL ₁₄₅	PL ₁₄₆	PL ₁₄₇	PL ₁₄₈	PL ₁₄₉	PL ₁₅₀	PL ₁₅₁	PL ₁₅₂	PL ₁₅₃	PL ₁₅₄	PL ₁₅₅	PL ₁₅₆	PL ₁₅₇	PL ₁₅₈	PL ₁₅₉	PL ₁₆₀	PL ₁₆₁	PL ₁₆₂	PL ₁₆₃	PL ₁₆₄	PL ₁₆₅	PL ₁₆₆	PL ₁₆₇	PL ₁₆₈	PL ₁₆₉	PL ₁₇₀	PL ₁₇₁	PL ₁₇₂	PL ₁₇₃	PL ₁₇₄	PL ₁₇₅	PL ₁₇₆	PL ₁₇₇	PL ₁₇₈	PL ₁₇₉	PL ₁₈₀	PL ₁₈₁	PL ₁₈₂	PL ₁₈₃	PL ₁₈₄	PL ₁₈₅	PL ₁₈₆	PL ₁₈₇	PL ₁₈₈	PL ₁₈₉	PL ₁₉₀	PL ₁₉₁	PL ₁₉₂	PL ₁₉₃	PL ₁₉₄	PL ₁₉₅	PL ₁₉₆	PL ₁₉₇	PL ₁₉₈	PL ₁₉₉	PL ₂₀₀	PL ₂₀₁	PL ₂₀₂	PL ₂₀₃	PL ₂₀₄	PL ₂₀₅	PL ₂₀₆	PL ₂₀₇	PL ₂₀₈	PL ₂₀₉	PL ₂₁₀	PL ₂₁₁	PL ₂₁₂	PL ₂₁₃	PL ₂₁₄	PL ₂₁₅	PL ₂₁₆	PL ₂₁₇	PL ₂₁₈	PL ₂₁₉	PL ₂₂₀	PL ₂₂₁	PL ₂₂₂	PL ₂₂₃	PL ₂₂₄	PL ₂₂₅	PL ₂₂₆	PL ₂₂₇	PL ₂₂₈	PL ₂₂₉	PL ₂₃₀	PL ₂₃₁	PL ₂₃₂	PL ₂₃₃	PL ₂₃₄	PL ₂₃₅	PL ₂₃₆	PL ₂₃₇	PL ₂₃₈	PL ₂₃₉	PL ₂₄₀	PL ₂₄₁	PL ₂₄₂	PL ₂₄₃	PL ₂₄₄	PL ₂₄₅	PL ₂₄₆	PL ₂₄₇	PL ₂₄₈	PL ₂₄₉	PL ₂₅₀	PL ₂₅₁	PL ₂₅₂	PL ₂₅₃	PL ₂₅₄	PL ₂₅₅	PL ₂₅₆	PL ₂₅₇	PL ₂₅₈	PL ₂₅₉	PL ₂₆₀	PL ₂₆₁	PL ₂₆₂	PL ₂₆₃	PL ₂₆₄	PL ₂₆₅	PL ₂₆₆	PL ₂₆₇	PL ₂₆₈	PL ₂₆₉	PL ₂₇₀	PL ₂₇₁	PL ₂₇₂	PL ₂₇₃	PL ₂₇₄	PL ₂₇₅	PL ₂₇₆	PL ₂₇₇	PL ₂₇₈	PL ₂₇₉	PL ₂₈₀	PL ₂₈₁	PL ₂₈₂	PL ₂₈₃	PL ₂₈₄	PL ₂₈₅	PL ₂₈₆	PL ₂₈₇	PL ₂₈₈	PL ₂₈₉	PL 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20. The resistance R_{33} in one of the H.T. positive leads lowers the voltage when the receiver only is in operation. It will be observed that when the switch S_3 (*see* fig. 2) is in the "transmit" position, the H.T. pins 1 and 2 of the plug P_1 are short-circuited, so that R_{33} is no longer in circuit; this arrangement maintains the voltage, which would otherwise drop, owing to the greater drain imposed on the H.T. by the transmitter valves. Sockets 1 and 2 of SK_3 are permanently short-circuited in the vibrator unit, since it is capable of delivering a steady voltage in spite of the extra load placed upon it.

CONSTRUCTIONAL DETAILS

Transmitter-receiver unit, type 2

21. The equipment, complete with loudspeaker, key and all other accessories, fitted in its transit case ready for operation, is shown in fig. 1. Space is provided at the back of the loudspeaker compartment for the storage of certain recommended spares.

22. The transmitter and receiver are mounted on a common chassis and, together with either the vibrator unit or A.C. mains unit, are housed in a plain metal case. The disposition of the controls on the front panel can be seen in fig. 1, whilst a bench wiring diagram of the top of the chassis is given in fig. 5, and one of the underside in fig. 6.

23. Referring to fig. 1, the ON/OFF switch, fuse and power supply cable (1) can be seen in the bottom left-hand corner of the instrument. These three items are attached to the chassis of both types of power unit in identical positions, so that they register with the holes in the front of the case irrespective of which power unit is in use. Next on the right is the switch S_1 , marked PHONE/CODE, by means of which the transmission of telephony or M.C.W. can be selected.

24. In the centre can be seen the socket block SK_1 for the key and loudspeaker, the correct positions of which are clearly marked by diagrammatic symbols. Further to the right is the five-pin socket block SK_2 for the telephone handset and additional earpiece.

25. In the bottom right-hand corner is the A.F. gain control R_{24} of the receiver, marked VOLUME, whilst above it can be seen the main tuning knob (2) which operates the two series-gap ganged condenser units C_{15} and C_{25} . The knob (3) marked ANT. COUP, which controls the aerial coupling of the receiver, is situated immediately above the tuning dial.

26. The cable connector (4) on the end of the aerial feeder line is shown connected in position to its two terminals in the top right-hand corner of the instrument. Adjacent to this can be seen the press-button switch S_4 , whilst immediately above is the R.F. indicating lamp PL_1 . By depressing S_4 the lamp is connected in the aerial circuit and affords a guide as to whether the transmitter is radiating.

27. The transmit-receive switch S_3 is situated to the left of the indicating lamp, and its three positions RE, R and T are clearly marked. It will be observed that a spring-loaded mechanical stop (5) is incorporated. This prevents the control lever of S_3 being swung over to the RE position unless the stop is first rotated by hand in a clockwise direction (*see* para. 53). If, however, it is desired to return from RE to either of the other two positions, the movement of the lever pushes the mechanical stop over to the right-hand side against the spring, after which it will return to its upright position.

28. The anode current of V_1 and V_2 can be measured by means of the meter M_1 in conjunction with S_2 which, when thrown over to the left, provides a reading for V_2 , and to the right for V_1 . Four fixing buttons (6), two of which are visible, are provided on the underside of the metal case, and register with corresponding keyways cut in two metal sliders fitted in the transit case. These sliders can be seen clearly in fig. 1 pushed back in their grooves and securing the instrument firmly in position.

29. A back view of the components mounted on top of the chassis, is given in fig. 7, from which it will be seen that the receiver portion is on the left-hand side and the transmitter on the right. In the foreground on the left-hand side is the double triode valve V_5 , whilst immediately behind is the screening box (1) covering the detector valve V_4 , and above this the R.F. pentode V_3 . The variable condenser unit C_{15} is ganged by means of a flexible drive to C_{25} , which is situated in the screened compartment behind V_4 . On the right-hand side of C_{15} is the inductance L_7 , to which L_8 can be variably coupled. Adjacent to V_5 can be seen the intervalve transformer T_3 , whilst above it and to the right is the variable resistance R_{23} , which is pre-set so that 100 volts is applied to the anode of V_4 .

30. Mounted on the front of the chassis are the R.F. indicating lamp PL_1 and the transmit-receive switch S_3 . To the right of this is the aerial inductance L_4 and the anode inductance L_3 of V_2 , the coupling between these being variable. The modulator transformer T_2 is mounted below R_{23} and on its right-hand side is the modulator valve V_1 . Next to it is the oscillator valve V_2 , and on the front of the chassis is the microphone transformer T_1 . The 5-pin plug P_1 is for connecting the transmitter-receiver unit to the power unit and carries the supply for the H.T. and the heaters.

31. A view of the underside of the chassis is shown in fig. 8, and the two holders for the transmitter valves can be seen on the left-hand side, whilst above them on the front of the chassis is the PHONE/CODE switch S_1 . The variable resistance R_{24} controlling the A.F. gain of the receiver is mounted in the top right-hand corner; between this and S_1 is the socket block SK_1 carrying the two double-pin sockets for the loudspeaker and key, also the 5-pin socket SK_2 for the telephone handset.

32. Situated on the right-hand side of the chassis is the output transformer T_4 , and below it the R.F. choke L_{11} in the anode circuit of V_4 . The two R.F. chokes L_5 and L_6 in the heater circuit of the transmitter valves are mounted at the back, whilst in the centre, the base of the frequency stabilizer FS_1 can be seen. Four lugs (one in each corner) drilled and tapped, are provided for fixing the chassis to the metal case.

Power unit, type 41

33. The vibrator unit operates in conjunction with a 6-volt accumulator, and occupies a space next to the transmitter-receiver unit. It is secured in position by means of four fixing screws on the underside of the main metal containing case. The vibrators, VIB_1 and VIB_2 , can be withdrawn from their holders and rotated so that their position corresponds with the diagram on top of the unit, according to whether a positive or negative earth supply is being used. Similarly, the reversing links can be reset to agree with the diagram affixed above them. On the right of the reversing links is the 5-pin output socket, to which the plug P_1 from the transmitter-receiver unit is connected.

Power unit, type 38

34. This unit, is designed to operate from A.C. mains, and supplies the necessary H.T. and heater current. It occupies the same space as the vibrator unit and is secured in position by the same four fixing screws. The output sockets for connection to the 5-pin plug from the transmitter-receiver unit, and the mains input adjusting links, are mounted on the back of the bottom compartment.

Aerial system, type 17

35. The mast consists of five sections, each 5 ft. in length, which can rapidly be erected for use. A metal base plate, ground pegs and two sets of guy rope assemblies with tension adjusters are provided. A matching section, two elements, which make up the vertical dipole, and 40 ft. of Lemons feeder cable complete the equipment, which can be seen set up for use in fig. 9.

INSTALLATION AND OPERATION

Fitting up the aerial

36. The matching section should be inserted through the hole in the lug on the top tube section of the mast, as shown in fig. 9, with the connection box close to the lug. The dipole elements can now be attached, and the matching section rotated so that they are aligned vertically with the mast, after which the clamping screw on the lug may be tightened.

37. The mast sections can now be fitted together with the lower guy rope assembly attached to the second section. The base plate should then be placed on the ground and the mast raised into position, when the ground pegs can be hammered into place and the tension adjusters on the guy ropes tightened.

38. Since the metal mast acts to a certain extent as a reflector, it is preferable to erect it so that the dipole elements are towards the direction in which the receiver lies.

Preliminary adjustments

39. The equipment can now be got ready for operation by letting down the front of the transit case, after unscrewing the two fixing screws along the top. It is assumed that a vibrator unit is in use, so that before connecting up the power supply lead, the instrument must be withdrawn from the transit case by pulling forward the two securing runners underneath the base board, and the back

cover removed after undoing the two fixing screws on the top of the metal case. The positions of the vibrator units and the reversing links must be checked in order to make sure that they correspond with their respective diagrams according to whether a negative or positive earthed supply is to be used. Ascertain that the ON/OFF switch on the front of the instrument is in the OFF position, after which the power supply lead can be connected up.

40. If a negative earthed supply is to be used the black lead must be connected to the negative terminal of the accumulator, and the red lead to the positive terminal. If an earth is used, this must be connected to the negative terminal. If, however, the instrument is to operate on a supply, the positive side of which is earthed, the black lead must be connected to the positive terminal and the red to the negative.

41. See that all the valves are in position, and refix the instrument in the transit case, having first replaced the back cover. Make sure that the fuse on the right-hand side of the ON/OFF switch is firmly in position. The cable connector on the end of the aerial feeder line should now be fixed in position under the two terminals as shown in fig. 1, and the telephone handset plugged into its socket SK₂, whilst the loudspeaker and tapping key may be connected up to SK₁ if required. The transmit-receive switch S₃ should be turned to the position marked R, since this enables the supply unit to become stable on the lighter load of the receiver, rather than switching it immediately on to the heavier load of the transmitter.

42. If the power supply is obtained from the A.C. mains unit, the same instructions will apply, though the only precaution necessary with regard to the unit itself is to make sure that the links on the voltage adjustment strip are correctly set to the mains input.

To receive

43. The ON/OFF switch should now be moved over to the ON position, and a period of between one and two minutes allowed for the heaters to warm up. Turn the receiver volume control R₂₄ (see fig. 1) in a clockwise direction until the characteristic hiss of a super-regenerative receiver is heard. Turn the tuning control knob (2) until a signal is received, or alternatively, if it is known that the signal which it is required to receive is being radiated, tune to this. Reference can be made, if necessary, to the calibration chart on the back of the cover plate (7) below S₃. Adjust the aerial coupling control (3), immediately above the tuning scale, for the best results, and rotate R₂₄ until the required signal strength is obtained.

To transmit

44. First turn the transmit-receive switch to the position marked T, and check that the transmitter is radiating as indicated by a glow from the R.F. indicator lamp PL₁, when the push button S₄ is depressed. It is important to note that before operating S₄ it is necessary to move the PHONE/CODE switch S₁ to the PHONE position.

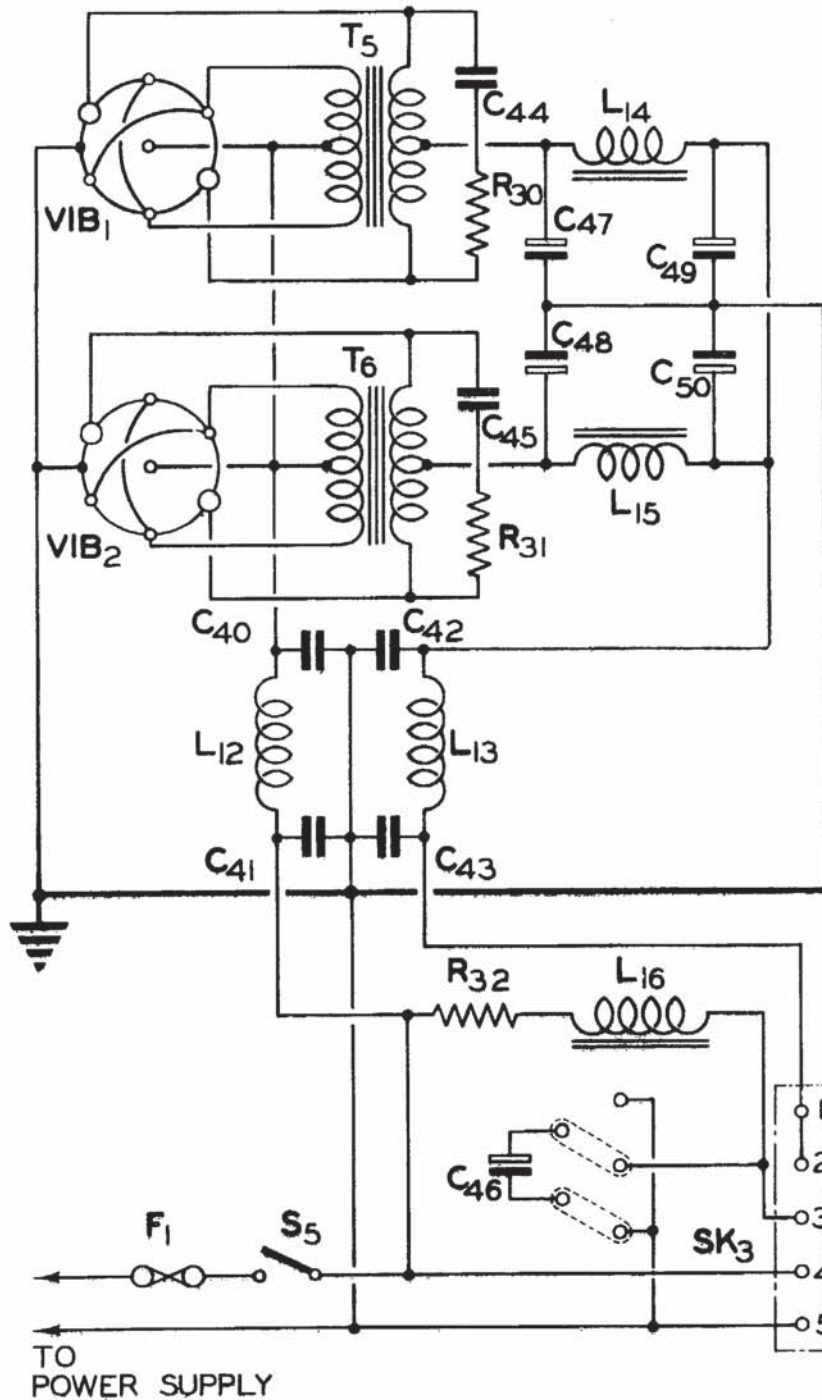
45. The anode current of the modulator valve should be checked by moving the switch S₂ over to the left, when a reading of the meter M₁ of approximately 60mA should be obtained. The PHONE/CODE switch S₁ should now be turned to the required position, when the transmitter will be ready for operation. It will be observed that the indicator lamp PL₁ normally remains short-circuited, since it is intended solely for checking purposes, and that it is brought into circuit only when S₄ is depressed.

Tuning of the transmitter

46. The instructions in the following paragraphs apply if it is desired to alter the frequency of the transmitter, or if it is considered that the variable circuits require re-alignment.

47. The cover plate (7) below S₃ must be removed by undoing the three fixing screws. This exposes the adjustable element of the frequency stabilizer FS, whilst in the top left and right-hand corners of the aperture, the screwdriver adjustment for the oscillator anode tuning C₁₁ and the aerial coupling can be seen.

48. A view of the frequency stabilizer FS₁ is given in fig. 10, and before making any adjustments the large milled-head screw (1) must be released. This screw serves the double function of a handle for rotating the top of the stabilizer, and a clamping device when the correct setting has been obtained. Adjustment to the desired position can now be made, by reference to the calibration curve on the back of the cover plate.



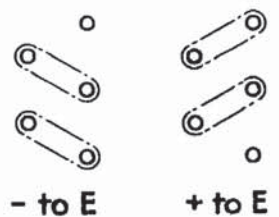
CONDENSERS

C40	375 μ F
C41	375 μ F
C42	375 μ F
C43	375 μ F
C44	0.01 μ F
C45	0.01 μ F
C46	250 μ F
C47	16 μ F
C48	16 μ F
C49	16 μ F
C50	16 μ F

RESISTANCES

R30	4700 Ω
R31	4700 Ω
R32	64 Ω

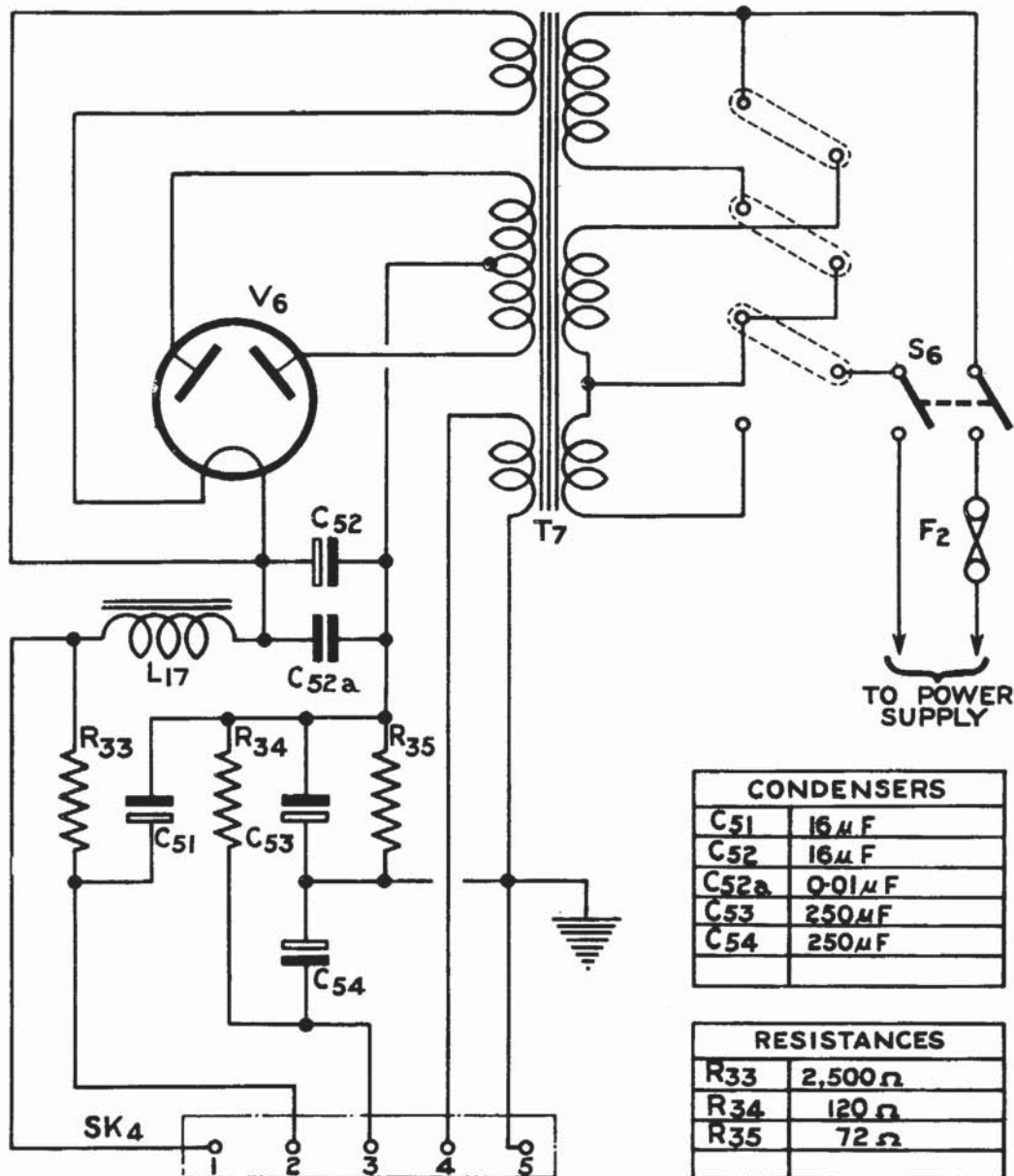
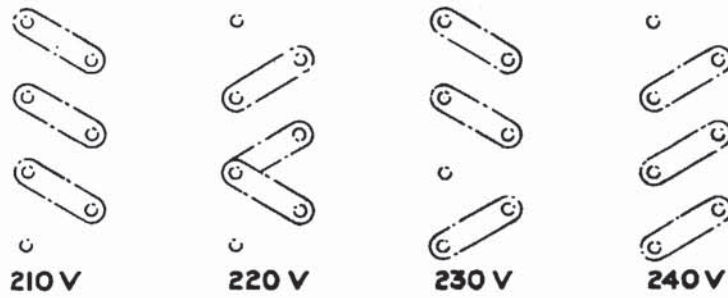
Reversing links



POWER UNIT TYPE 41, THEORETICAL CIRCUIT DIAGRAM

FIG. 3

FIG. 3



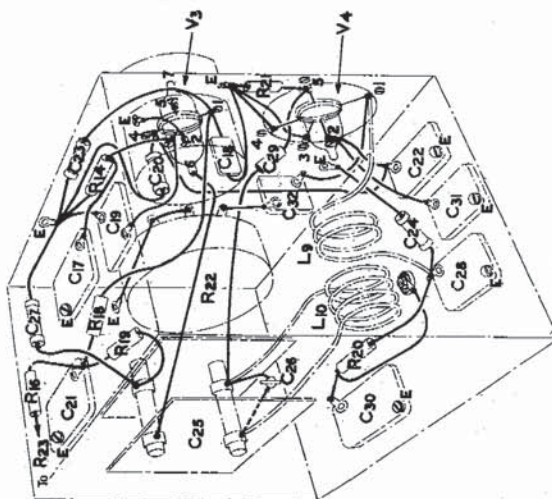
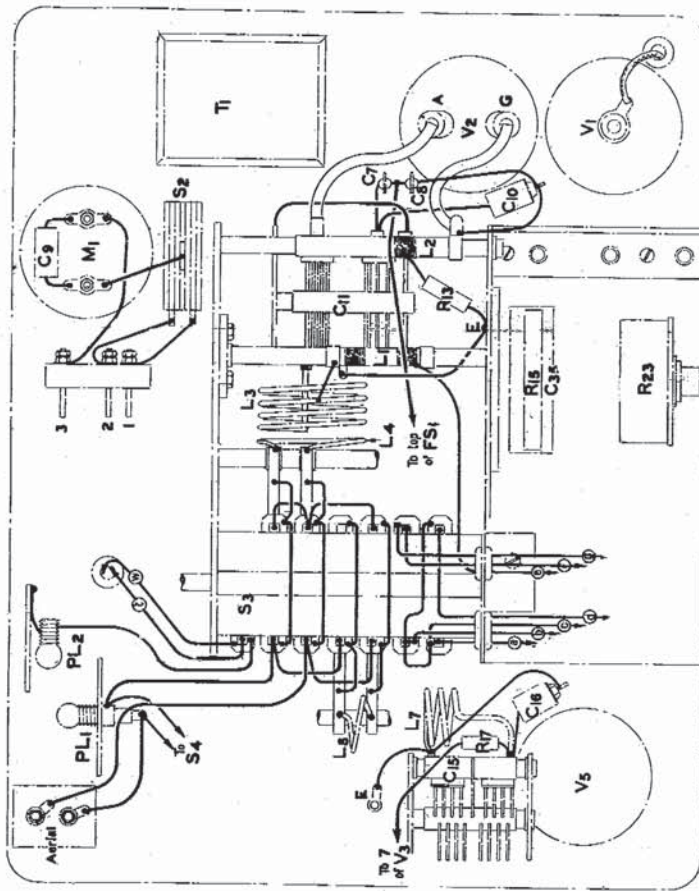
CONDENSERS	
C51	16 μ F
C52	16 μ F
C52a	0.01 μ F
C53	250 μ F
C54	250 μ F

RESISTANCES	
R33	2,500 Ω
R34	120 Ω
R35	72 Ω

POWER UNIT, TYPE 38, THEORETICAL CIRCUIT DIAGRAM

FIG.4

FIG.4



RECEIVER

T.R. 1148A, BENCH WIRING DIAGRAM (TOP OF CHASSIS)

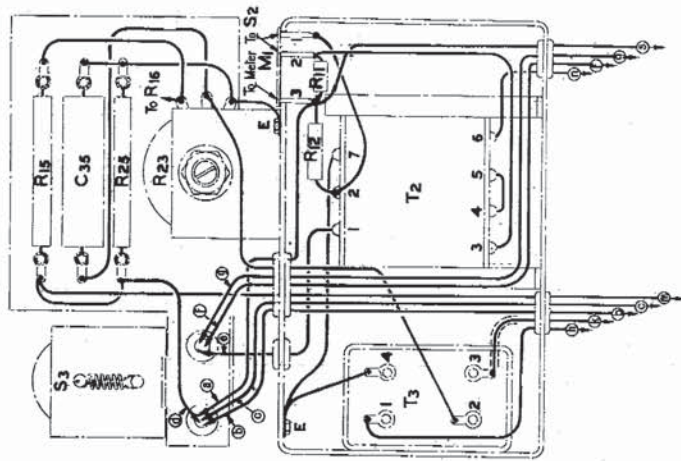
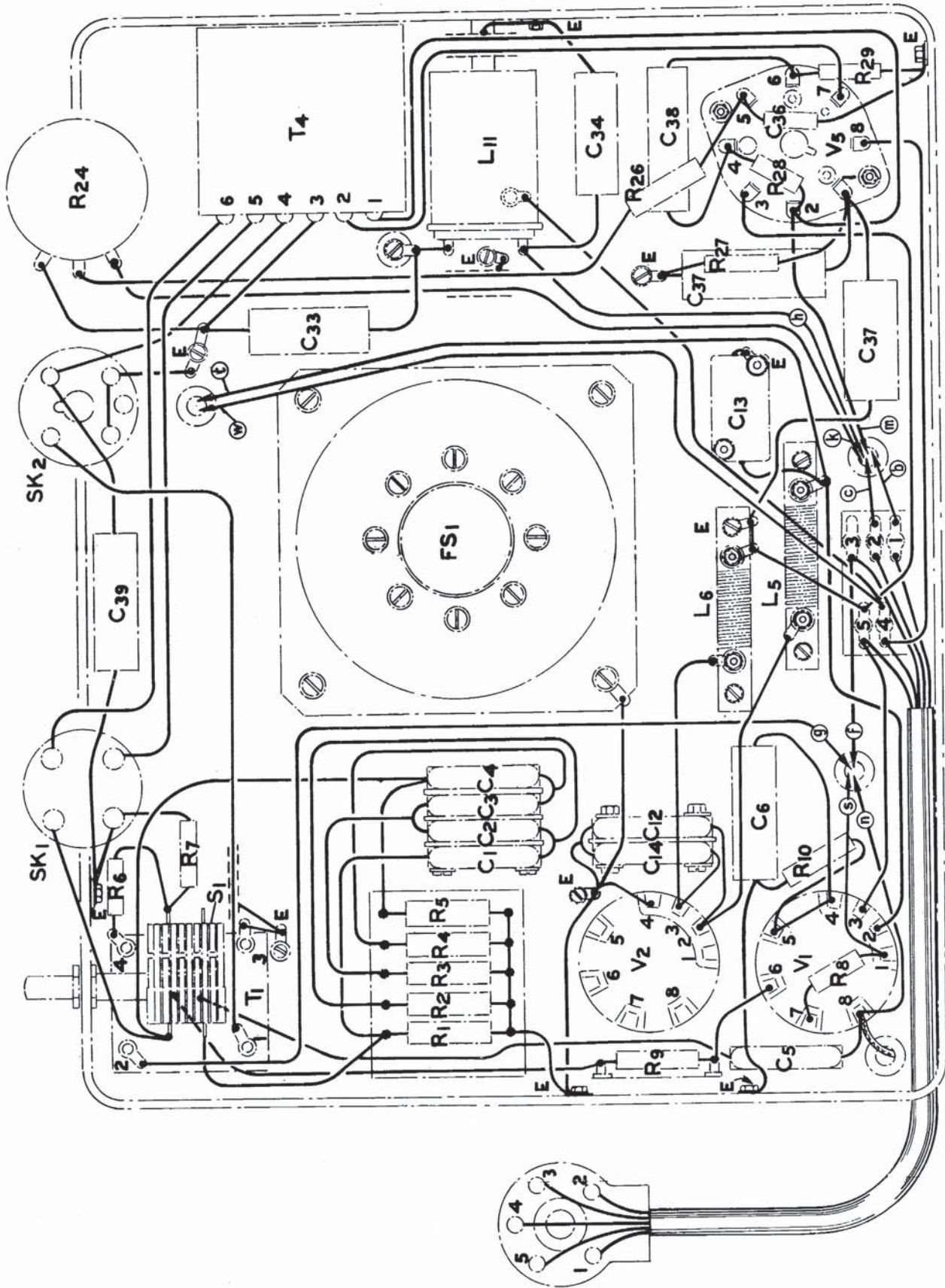


FIG. 5

FIG. 5



T.R. 1148 A, BENCH WIRING DIAGRAM (UNDERSIDE OF CHASSIS)

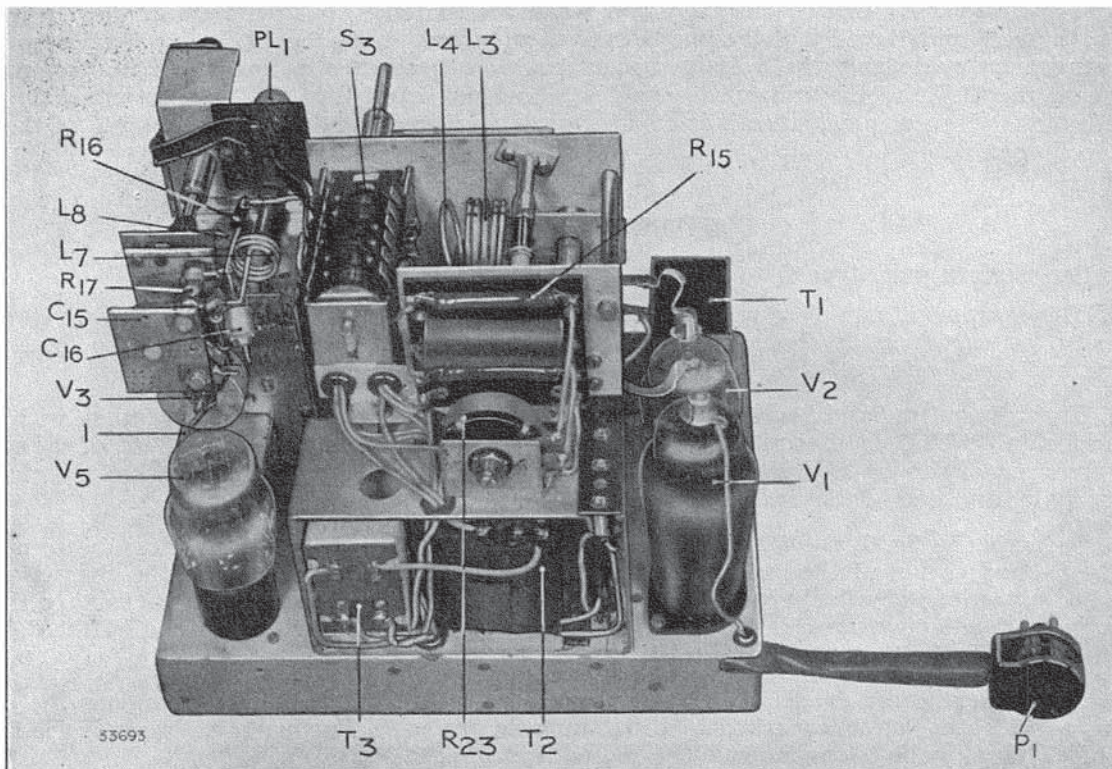


Fig. 7. Chassis removed from case.

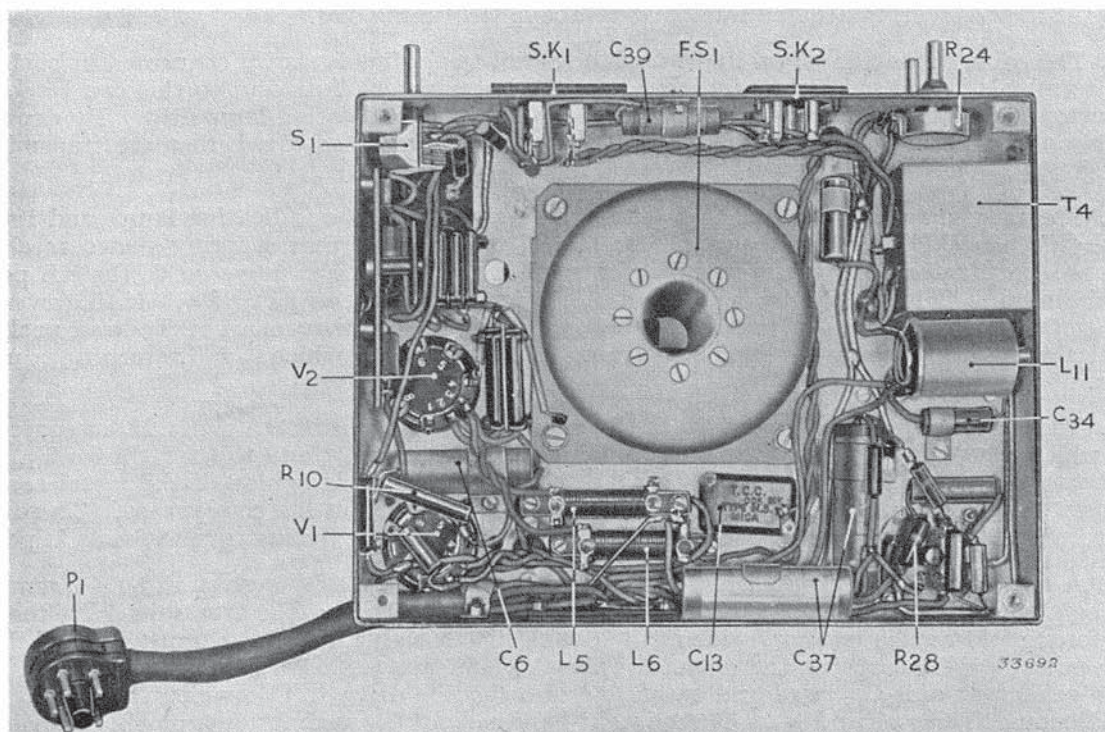


Fig. 8. Underside of chassis.

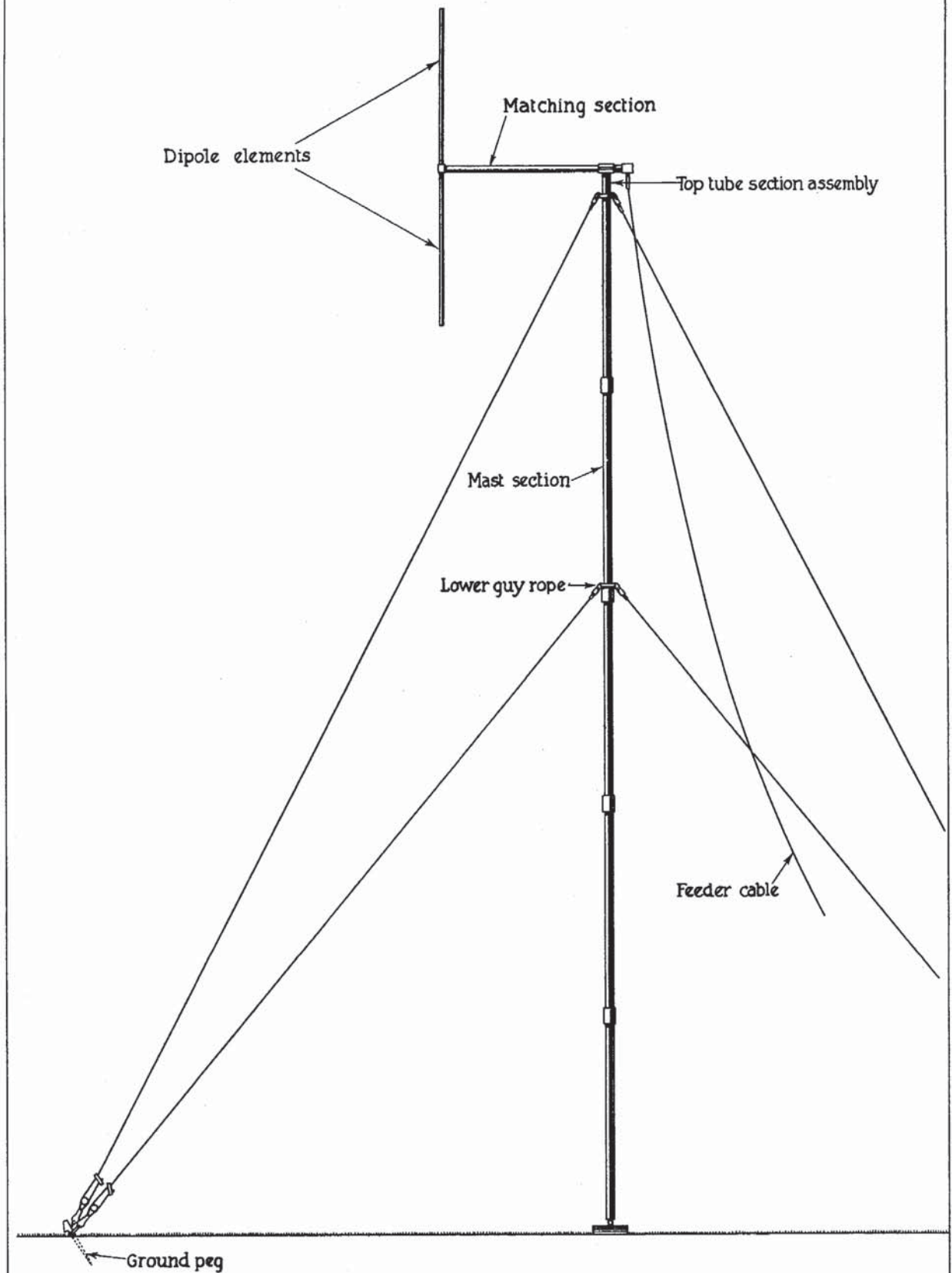


FIG. 9

AERIAL MAST ASSEMBLY

FIG. 9

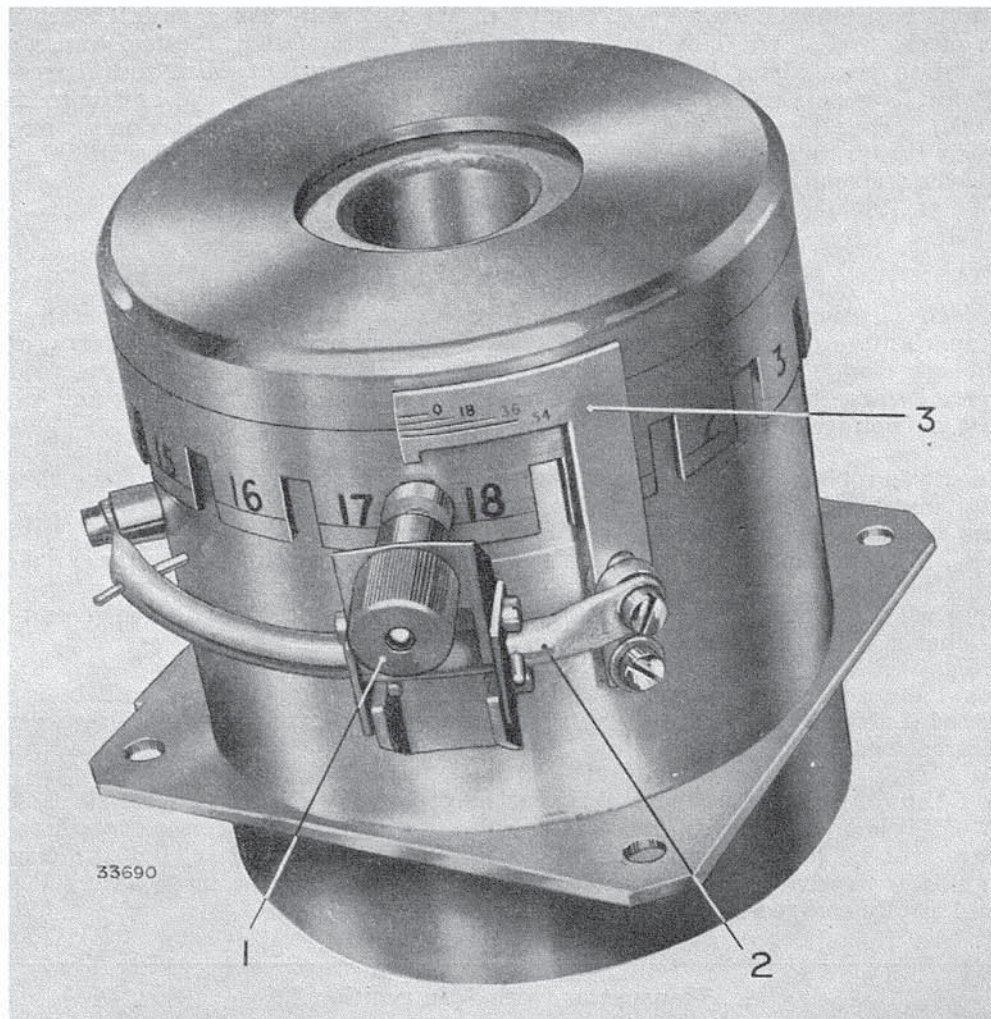


Fig. 10. Frequency stabilizer.

49. The top element is rotated by moving the head of the screw (1) into one of the notches and sliding the unit along the rail (2). The number of complete turns of the rotatable head is indicated on the line scale (3), there being eighteen notches to one complete turn. The number of each notch is engraved on its right-hand side, so that when the screw (1) has been inserted into the correct notch and the unit moved along the rail towards the right until the stop is reached, this number will be immediately below the line scale.

50. The milled-head screw should now be tightened so that the top element is clamped firmly in position, and the transmit-receive switch S_3 put in the position marked T.

51. The locking screws alongside the aerial coupling adjustment and the anode tuning adjustment C_{11} must be slackened, and the meter switch S_2 moved over to the right-hand position. Slacken off the aerial coupling in a counter-clockwise direction and adjust C_{11} until a dip in the reading of the oscillator anode current is observed on M_1 . Now turn C_{11} again in a counter-clockwise direction until the meter shows a reading of approximately 40mA, and tighten up the aerial coupling until maximum glow is obtained from the indicator lamp PL_1 with S_4 depressed.

52. Small adjustments to C_{11} and the aerial coupling should be made alternatively to obtain maximum current in the aerial feeder as indicated by PL_1 . When the transmitter is correctly tuned, the oscillator anode current should be between 40mA and 50mA. The locking screws for C_{11} and the aerial coupling must now be tightened up and the cover plate replaced.

Stand-by receive

53. A third position, RE (receive economy), of the transmit-receive switch S_3 , is available on releasing the mechanical stop. This position switches off the heaters of the two transmitter valves, and is intended to be used for the economy of accumulator current when the instrument has to "stand-by" for long periods. The loudspeaker should be connected up, and immediately upon receipt of a call, S_3 should be set to the position R in order that the transmitter valves may have time to warm up in readiness for the reply. During normal two-way communication, the mechanical stop prevents the transmitter valve heaters being unintentionally switched off.

PRECAUTIONS AND MAINTENANCE

54. On each occasion that the instrument is set up for operation with a vibrator power unit it is most important to check the accumulator supply for positive or negative earth, and to make sure that the vibrator units and reversing links are correctly positioned. Failure to do this may result in severe damage to the electrolytic condensers. If an A.C. mains power unit is being used, ascertain that the voltage adjustment links are set to the mains input.

55. In order to replace the tuning scale lamp PL_2 , it is necessary to remove the chassis from its metal case by unscrewing the four fixing bolts on the underside. Should it be necessary to take out the two acorn valves V_3 and V_4 , the tops of their screening boxes must be removed after having first withdrawn V_5 . The valves should be firmly gripped by the glass tip and gently eased out of their holders, at the same time taking care not to disturb the position of any of the wiring. The same remarks apply when replacing, and care should be exercised to see that the valves are the correct way round—that is, with the long portion inside the screening box.

56. Should the instrument fail altogether, the fuse in the power unit should be examined and a new one fitted if necessary. If there is still no output, the vibrator units or valve, as the case may be, should be replaced.

57. Should, however, the instrument appear only partially defective, a check should be made of the H.T. voltages on the valves, and this should afford some indication as to where the trouble lies. Voltages will be found to vary slightly with individual receivers, but the following table provides a guide as to what may be expected. Measurements must be made with a high-resistance voltmeter and a fully charged 6-volt accumulator.

Transmitter (with S_3 in position T)				
Valve	Anode	Screen	Bias	Heater
Modulator V_1 .. (unmodulated)	215	225	11	5.5
Oscillator V_2 ..	220	—	—	5.5
Receiver (with S_3 in position R)				
R/F Stage V_3 ..	60	30	0.9	5.7
Detector V_4 ..	100	—	—	5.7
A/F Stage V_5 ..	200	—	5	5.7
Output Stage V_5 ..	260	—	—	—

If an A.C. mains unit is used, the voltages will be slightly higher than those given in the table.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. When ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
10D/285	Transmitter-receiver, type T.R.1148A			
5A/1091	Comprising :— Accumulator, type B	1		For use with 10K/35 if required.
10B/288	Aerial system, type 17	1		
10D/82	Case, transit	1		
10D/83	Case, transit, accumulator	1		
10B/158	Case, transit, aerial system, type 9	1		
10A/12125	Handset, telephone, type 2	1		P.O. pattern.
10F/127	Key, morse, type K	1		
10U/7	Loudspeaker, type 9	1		
10K/35	Power unit, type 41	1		6-volt supply.
10K/25	Power unit, type 38	1		A.C. supply.
10A/12123	Receiver, telephone, head, type 12	1		P.O. pattern.
10D/354	Transmitter-receiver unit, type 2	1		
	Aerial system, type 9			
	Principal components :—			
10B/212	Aerial tube assembly	1		Containing central feeder and connecting box.
10B/205	Block, connecting	2		
10B/202	Dipole	2		
10B/378	Feeder	1		Dr. Lemon's feeder wire.
10B/386	Guy-rope assembly	1		Fitted with 3 stays, mast, type 2.
10B/375	Mast, lower section	1		Tubular.
10B/376	Mast, intermediate section	3		Tubular.
10B/377	Mast, upper section	1		Tubular, fitted with 3 stays, mast, type 3.
10B/206	Peg, ground	3		
10B/203	Plate, base	1		
10B/208	Ring	6		For connecting guy-rope assembly to pegs, ground.
10B/380	Stay, mast, type 2	3		21 ft. long.
10B/385	Stay, mast, type 3	3		30 ft.
	Power unit, type 41			
	Principal components :—			
10C/845	Choke, R.F., type 77	1	L_{16}	200 μ H.
10C/846	Choke, L.F., type 55	2	L_{14}, L_{15}	8 H.
	Condenser :—			
10C/842	Type 855	8	$C_{44}, C_{45},$	0.01 μ F., 4 in series-parallel.
10C/843	Type 856	4	$C_{47}, C_{48},$	16 μ F. electrolytic.
			C_{49}, C_{50}	
10C/844	Type 857	1	C_{46}	250 μ F. electrolytic.
10K/38	Filter unit, type 4	1		Fitted with 1 choke, type 78, and 1 choke, type 79 (L_{12} and L_{13}).
10H/269	Fuse, type 31	1	F_1	15 ampere, cartridge.
10H/1111	Holder, fuse, type 25	1		Panel mounting.
10A/12225	Plate, reversing	1		

Ref. No.	Nomenclature.	Qty.	Ref. in fig. 2.	Remarks.
	Transmitter-receiver, type T.R.1148A —(contd.)			
	Transmitter-receiver unit, type 2— (contd.)			
	Principal components—(contd.)			
	Condenser—(contd.)			
10C/743	Type 829	1	C ₁₆	30μF.
10C/2561	Type 1,208	1	C ₂₉	60μF.
10C/10629	Type 440	1	C ₃₂	0.01μF.
10C/745	Type 831	1	C ₃₆	300μF.
10C/16	Type 572	1	C ₂₆	10μF.
	Inductance :—			
10C/722	Type 44	1	L ₃	
10C/723	Type 45	1	L ₄	
10C/724	Type 46	1	L ₇	
10C/725	Type 47	1	L ₈	
10C/726	Type 48	1	L ₁₀	
10C/727	Type 49	1	L ₉	
5A/	Lamp, 2 volt, 0.1 amp.	1	PL ₁	R.F. indicator lamp.
5A/1428	Lamp, 6 volt, 0.04 amp.	1	PL ₂	Scale lamp.
10A/12213	Milliammeter, type C	1	M ₁	Moving coil, 0–100 mA.
	Resistance :—			
10C/747	Type 885	1	R ₁₃	2,800 ohms.
10C/748	Type 886	1	R ₁₀	195 ohms.
10C/749	Type 887	5	R _{1, R₂, R₃, R₄, R₅}	0.12 megohm.
10C/750	Type 888	2	R _{11, R₁₂}	42 ohms.
10C/751	Type 889	1	R ₁₄	1,200 ohms.
10C/752	Type 890	1	R ₁₈	0.18 megohm.
10C/753	Type 891	1	R ₁₉	4,700 ohms.
10C/754	Type 892	1	R ₂₁	0.56 megohm.
10C/755	Type 893	1	R ₂₀	1,250 ohms.
10C/758	Type 896	2	R _{15, R₂₅}	20,000 ohms.
10C/760	Type 898	1	R ₂₉	0.33 megohm.
10C/11678	Type 512	1	R ₉	1,000 ohms.
10C/53	Type 561	2	R _{8, R₁₇}	100 ohms.
10C/11687	Type 521	1	R ₂₈	50,000 ohms.
10C/27	Type 544	2	R _{6, R₇}	10,000 ohms.
10C/763	Type 901	1	R ₁₆	0.16 megohm.
10C/764	Type 902	1	R ₂₃	0.1 megohm, variable.
10C/765	Type 903	1	R ₂₄	0.2 megohm, variable.
10C/766	Type 904	1	R ₂₂	0.1 megohm, variable.
10D/173	Stabilizer	1	FS ₁	Frequency stabilizer.
	Switch :—			
10F/503	Type 450	1	S ₃	Transmit-receive switch.
10F/182	Type 255	1	S ₁	PHONE/CODE switch.
10F/183	Type 256	1	S ₂	Meter switch.
10F/504	Type 451	1	S ₄	R.F. indicator press switch.
	Transformer :—			
10A/12216	Type 150	1	T ₂	Modulation transformer.
10A/12217	Type 151	1	T ₁	Microphone transformer.
10A/12218	Type 152	1	T ₃	A.F. transformer.
10A/12219	Type 153	1	T ₄	Telephone transformer.
	Accessories :—			
10E/130	Valve (Mullard TV.05/12)	1	V ₂	Oscillator.
10E/131	Valve (Mullard E.L.50)	1	V ₁	Modulator.
10E/132	Valve (Mullard 4672)	1	V ₃	R.F. amplifier.
10E/133	Valve (Mullard 4671)	1	V ₄	Detector.
	Valve (Mullard ECC31)	1	V ₅	A.F. and output.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Transmitter-receiver, type T.R.1148A —(contd.)			
	Power unit, type 41 (contd.)			
	Principal components (contd.)			
	Resistance :—			
10C/848	Type 850	1	R ₃₂	64 ohms.
10C/1646	Type 1,646	2	R ₃₉ , R ₃₁	4,700 ohms.
10F/239	Switch, type 261	1	S ₅	S.P. ON/OFF.
10A/12224	Transformer, type 155	2	T ₅ , T ₆	Vibrator transformer.
	Accessories :—			
10H/268	Clip, type 7	2		25-ampere battery clip.
10A/12124	Vibrator unit, type 2	2	VIB ₁ , VIB ₂	6-volt.
	Power unit, type 38 :—			
	Principal components :—			
10C/2643	Choke, L.F., type 91	1	Ref. in fig. 4 L ₁₇	6 H.
	Condenser :—			
10C/843	Type 856	2	C ₅₁ , C ₅₂	16μF., electrolytic.
10C/2637	Type 1,259	1	C _{51A}	0.01μF.
10C/844	Type 857	2	C ₅₃ , C ₅₄	250μF., electrolytic.
10H/10269	Fuse, type 13	1	F ₂	2-ampere, cartridge.
10H/376	Holder, fuse, type 13	1		Panel mounting.
10H/640	Holder, valve, type 87	1	V ₆	8-side contact, moulded.
	Resistance :—			
10C/1501	Type 1,501	1	R ₃₅	72 ohms.
10C/1502	Type 1,502	1	R ₃₄	120 ohms.
10C/1215	Type 1,215	1	R ₃₃	2,500 ohms.
10H/211	Socket, type 99	1	SK ₄	5-way with centre guide-hole.
10F/111	Switch, type 223	1	S ₆	D.P. ON/OFF.
10A/12552	Tapping panel	1		Fitted with adjustable links.
10K/177	Transformer, type 296	1	T ₇	Input voltage 110, 130, 220, 240, 50 cycles.
	Accessories :—			
10E/379	Valve (Mullard AZ.2)	1	V ₆	Side contact base.
	Transmitter-receiver unit, type 2 :—			
	Principal components :—			
	Choke R.F. :—			
10C/717	Type 72	1	Ref. in fig. 2 L ₁	
10C/718	Type 73	1	L ₂	
10C/719	Type 74	2	L ₅ , L ₆	
10C/721	Type 76	1	L ₁₁	100μH.
	Condenser :—			
10C/728	Type 814	1	C ₈	16μμF.
10C/729	Type 815	1	C ₇	4μμF.
10C/730	Type 816	1	C ₁₀	Ceramic trimmer.
10C/731	Type 817	1	C ₁₁	2 × 30μμF.
10C/10875	Type 491	3	C ₁₂ , C ₁₃	0.005μF.
			C ₁₄	
10C/733	Type 819	1	C ₆	25μF., electrolytic.
10C/734	Type 820	5	C ₁ , C ₂ , C ₃ , C ₄ , C ₅	0.0016μF.
10C/2930	Type 1,407	1	C ₂₅	2 × 30μμF.
	Type	1	C ₁₅	2 × 30μμF.
10C/2972	Type 1,427	1	C ₂₇	400μμF.
10C/737	Type 823	1	C ₃₃	0.005μF.
10C/738	Type 824	1	C ₃₄	0.01μF.
10C/739	Type 825	1	C ₃₅	0.25μF.
10C/11076	Type 503	1	C ₉	0.1μF.

APPENDIX 2

REMOTE CONTROLS, TYPE 10 (Stores Ref. 10J/112)

INTRODUCTION

1. Remote controls type 10 are designed to work in conjunction with control unit type 88 (Stores Ref. 10L/37), the associated transmitter T1190 or T1190A being keyed by an audio-frequency tone generated in the control unit, and sent over landlines to the remote controls at the W/T transmitting station. A description of the control unit type 88 is given in Section 6, Chapter 14 of this publication. By the method just described, known as tone-to-line keying, control can be obtained over far greater distances than is possible with impedance keying as used in remote controls types 2, 3, 4, 5, 6 and 7.

2. In general layout and construction, remote controls type 10 are similar to remote controls type 3, but the amplifier A1104 has been modified so that the valve V_3 , which in the type 3 controls acted as a local oscillator for M.C.W., can now be used as a pre-amplifier when working over long lines, and M.C.W. is no longer available. The amplified keying tone is passed from the amplifier A1104 to a metal rectifier, the output of which operates the keying relay. Arrangements for H.T. switching are the same as in the type 3 controls, but the relay for remote filament switching and its associated local control switch have been omitted. The 24 volts for operation of the H.T. relay are fed from the battery supply of the control unit type 88 over the A and B lines to the remote controls.

GENERAL DESCRIPTION

3. It will be seen from fig. 1 that the circuit of the valve V_3 in the local control panel of the amplifier A1104 has been modified so that it works as an A/F amplifier instead of as an oscillator as before, the transformer T_1 which formerly provided anode-to-grid feedback having its windings connected in series so as to act as an anode choke. The A and B lines from the W/T cabin are connected to the corresponding terminals on the strip at the base of the remote control panel (fig. 2) and across these is the primary winding of the repeating coil. In this winding are present both the audio-frequencies (speech or keying tone) and the 24 volts d.c. for the H.T. relay. Only the audio frequencies appear in the secondary, and are taken to two terminals on a strip at the top of the remote control panel, engraved 600 OHMS. Links connect these terminals to a pair similarly marked on a terminal strip at the base of the local control panel.

4. The input to the local control panel is taken from the 600 OHM terminals to the primary of a matching transformer (T_2 , fig. 1). When the switch S_1 on the panel is at 600 OHMS INPUT the secondary of this transformer is connected to a telephone jack J_2 at the side of the panel and fed over an external flexible connector to a similar jack, J_1 , in the input circuit of the amplifier panel, see fig. 4 of main chapter. When the switch is at PRE-AMPLIFIER the transformer secondary voltage is applied to the grid of the valve V_3 , and the amplified voltages in the anode circuit of this valve are passed to the output jack and thence to the amplifier panel. H.T. is permanently on the anode of V_3 , whereas in the type 3 controls it was applied only when S_1 was at osc.

5. The circuit arrangements with the switch in the LOCAL MICROPHONE and DIRECT-GRID positions are the same as those described in paras. 26, 27 and 30 of the main chapter. It should be noted, however, that if for any reason high input impedance R/T modulation is required with these controls, the modulation source must be connected direct to the terminals marked 50,000 OHMS DIRECT GRID on the local control panel, as the P.O. LINES terminals provided on the remote control panel of the type 3 controls are omitted in the present version. In these circumstances the A and B lines are used only for remote H.T. switching.

6. With high impedance R/T lines on the 50,000 OHM DIRECT GRID terminals and the switch S_1 at DIRECT GRID, the line matching transformer T_2 and the pre-amplifier stage are out of circuit and the input is taken direct *via* J_2 to the grid of V_1 in the amplifier A1104.

7. The secondary of the output transformer of the amplifier A1104 is connected to two two-pole sockets in parallel, from either of which an external flexible connector can be taken to two terminals marked OUTPUT A1104 on the terminal strip at the top of the remote control panel. When the ganged W/T-R/T switches on this panel are at R/T, these terminals are connected to the two terminals marked INPUT TRANSMITTER on the strip at the bottom of the same panel. When the switches are at W/T, the output of the amplifier is applied to the metal rectifier (fig. 2), the d.c. output of which operates the keying relay.

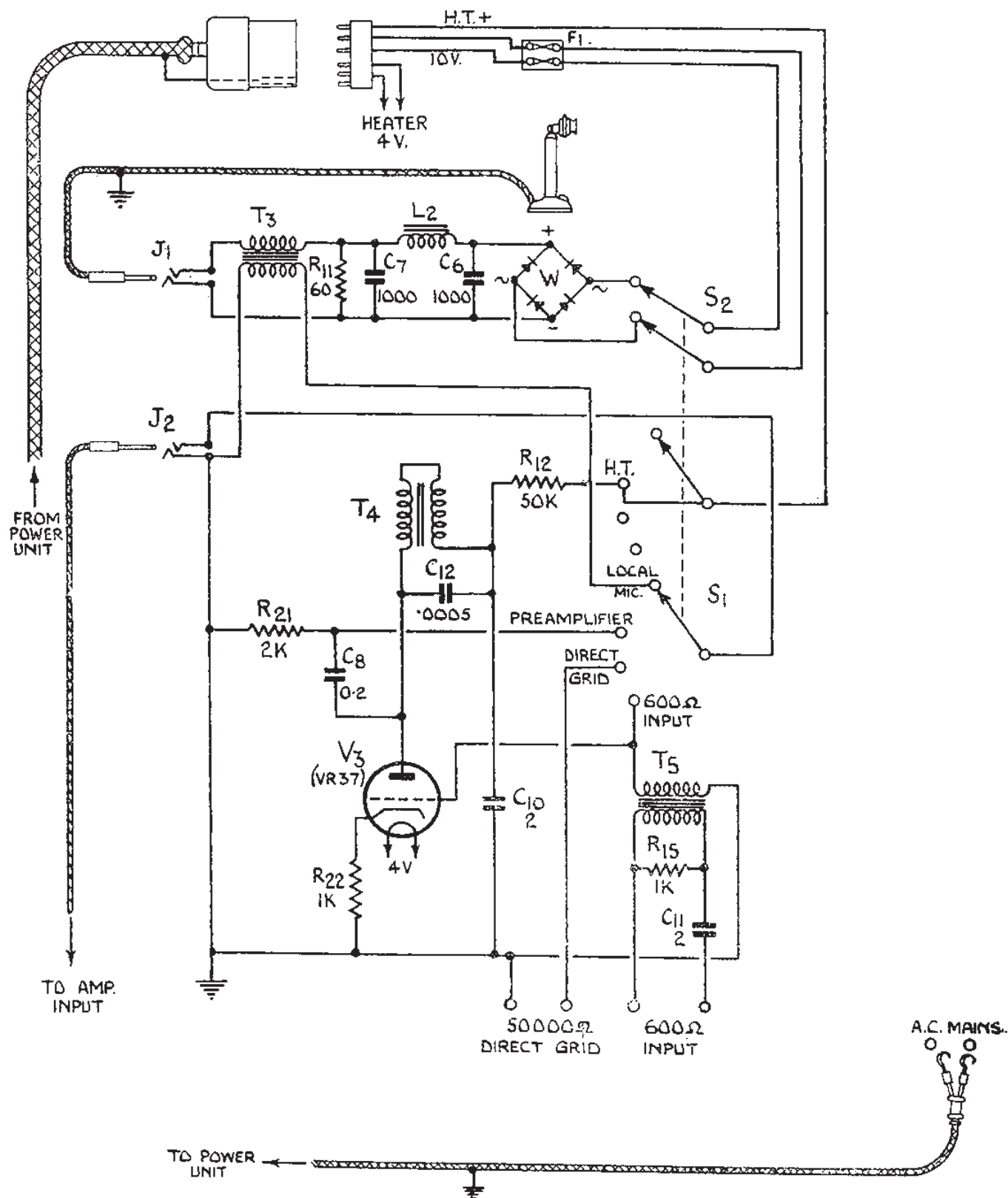


Fig. 1.—Circuit of local control panel, A.1104, as used in remote controls, type 10

8. For R/T operation the INPUT TRANSMITTER terminals mentioned in para. 7 are connected to the transmitter by a flexible connector type 683 (Stores Ref. 10H/1916) which terminates at the transmitter end in a two-way plug type 86 (Stores Ref. 10A/9603) with a central pin for operating the switch socket on the transmitter.

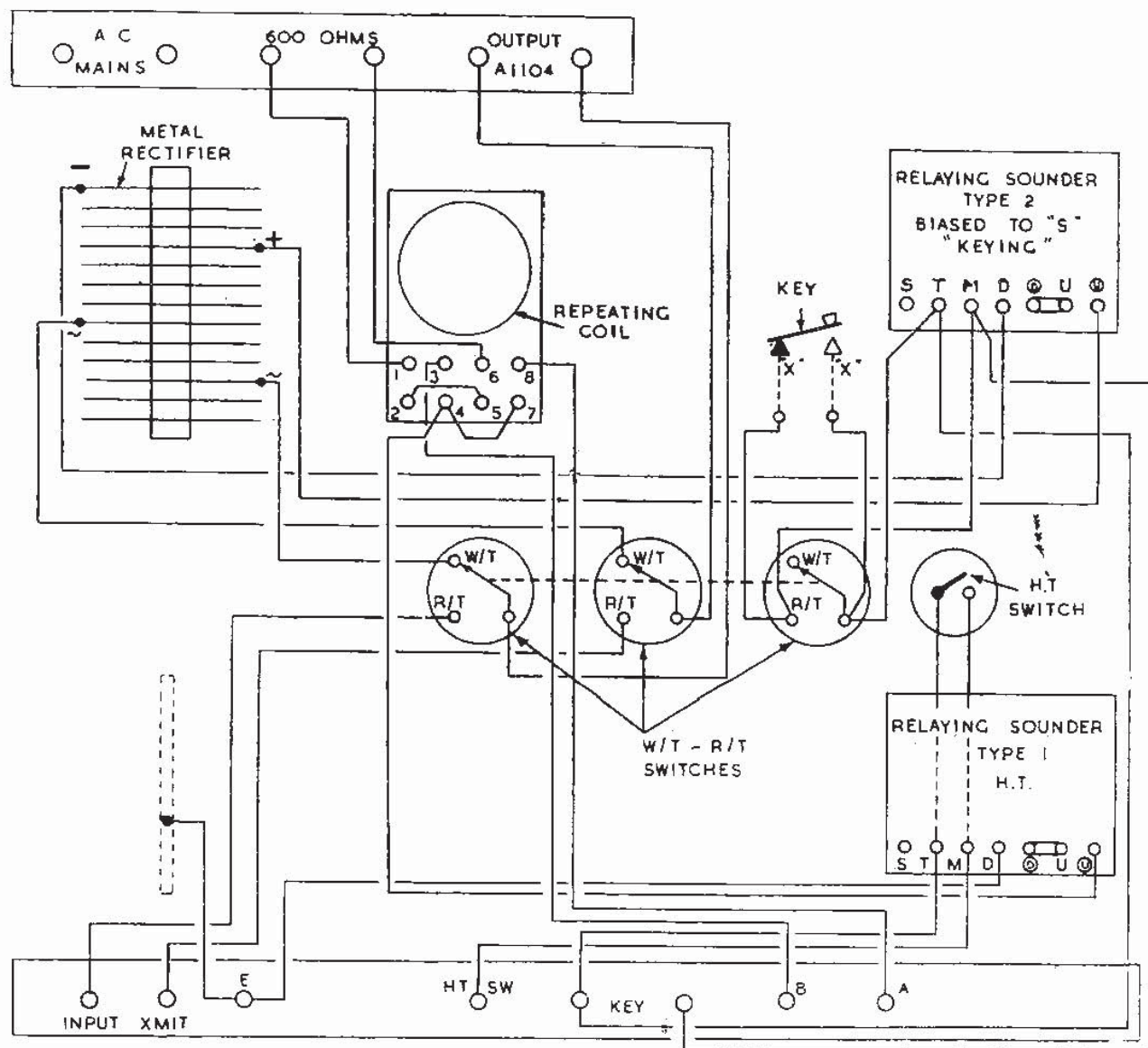


Fig. 2.—Diagram of rear of remote control panel showing location of parts

OPERATING INSTRUCTIONS

9. Paragraphs 72 to 78 of the main chapter apply in the main to remote controls type 10, but the normal reading of the milliammeter M should be 110mA unmodulated, this being set by the variable bias resistor R_{18} (fig. 4, main chapter). The control knob of this resistor is seen at (44) in fig. 10 of the main chapter.

10. To produce reasonably distortionless output from the amplifier A1104 the milliammeter reading should not vary more than 10 to 15 mA during modulation. The attenuator switch S_3 should be set at a position where the volume control R_8 allows this condition to be obtained. Component references in this paragraph are to fig. 4, main chapter.

11. It should be noted that if high impedance R/T modulation is used, as described in para. 5, the control unit type 88 can still be used for remote H.T. switching over the normal A and B lines. In no circumstances should the control unit type 88 be used connected to the 50,000 OHMS DIRECT GRID terminals.

12. The switch S_1 need be turned to PRE-AMPLIFIER only if keying is found unsatisfactory when working over long lines.

3. The terminals on the strip at the bottom of the remote controls (except the A and B and INPUT TRANSMITTER terminals) are connected to terminals correspondingly marked on the transmitter T1190 or T1190A. Terminals marked 14 v A.C. on the transmitter are left blank and the terminal marked F1R SW on the transmitter must be connected to the transmitter terminal marked H.T. SW.

14. The power supply for the remote controls is connected to the two terminals marked A.C. MAINS on the strip at the top of the remote control panel (see fig. 2). These are linked to terminals similarly marked (see fig. 1) on a strip at the bottom of the local control panel, whence a flexible connector type 7 is taken to a two-pin plug on the rectifier panel of the amplifier.

15. In a certain number of local control panels (panel, type 7, Stores Ref. 10D/9590) the connection was omitted which maintains the H.T. supply to V_3 irrespective of the position of S_1 (see para. 4). The pre-amplifier is thus left without grid bias and the grid and cathode form a diode circuit across the input, causing severe distortion. Instructions for examination of the panel and insertion of the connection if omitted are given in Vol. II, leaflet A.P.1186/K1. The following items of equipment are required:—

<i>Stores Ref.</i>	<i>Nomenclature</i>	<i>Quantity</i>
5E/1780	Wire, copper, H.C., No. 20 s.w.g.	As reqd.
5F/2121	Tubing, insulating, H.T., Grade E, 1 mm.	As reqd.

16. The sequence of operations is as follows:—

- (i) Remove panel, type 7, from the rack.
- (ii) Identify the resistance panel to the rear, and slightly to the left, of the tray. The right-hand resistance is of value 50,000 ohms. If from the rear end of this resistance two leads are connected, one to the switch on the front panel and one to the six-pole plug on the rear panel, the wiring is correct and no action is called for. If, however, the latter connection is absent, proceed as follows.
- (iii) Bare and tin $\frac{1}{2}$ in. of wire on the existing plug-to-switch connection and solder an insulated lead from the rear end of the 50,000 ohm resistance to this point.

FOR OFFICIAL USE ONLY

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SECTION 2, CHAPTER 7

TRANSMITTER-RECEIVER T.R.1150

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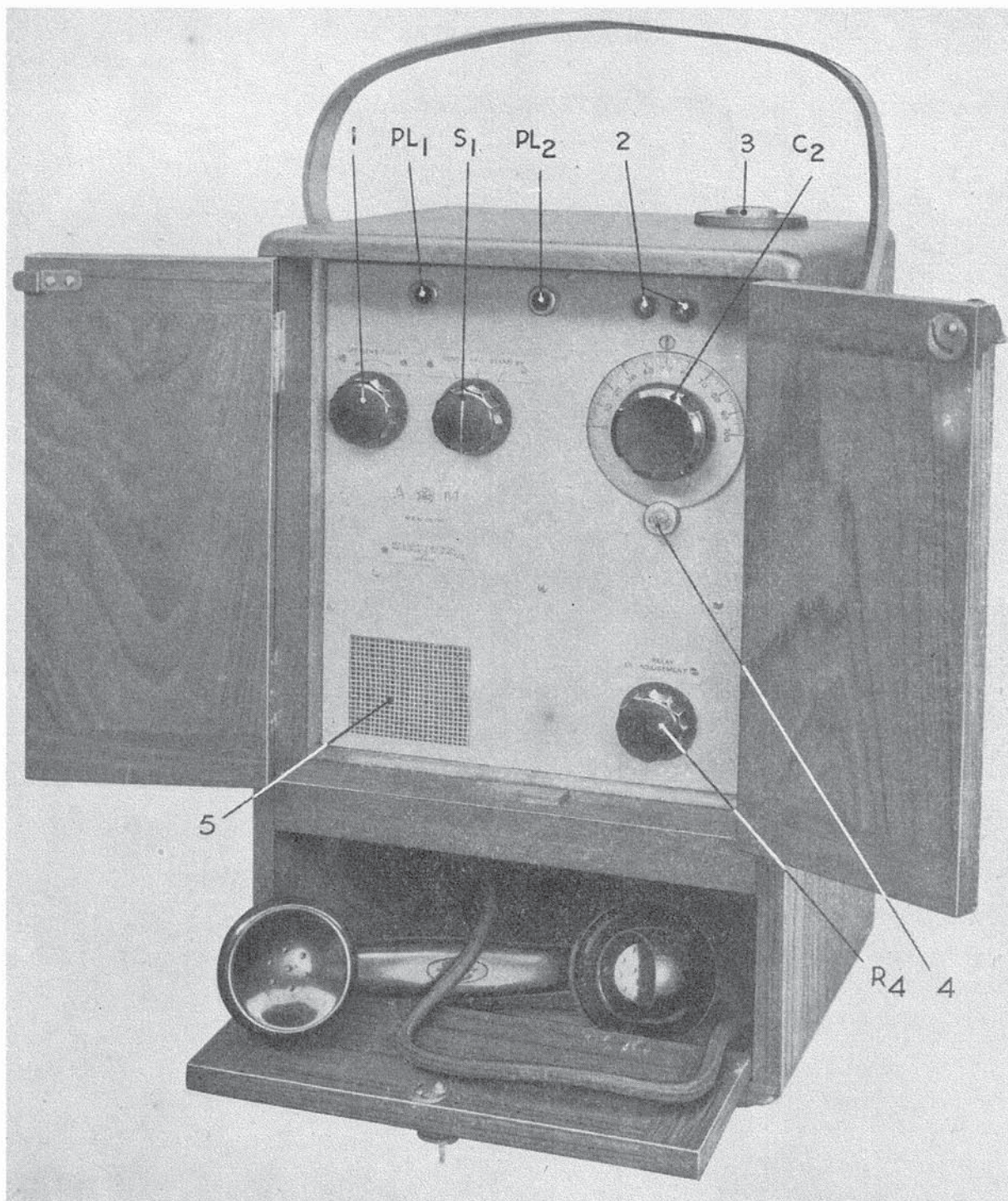
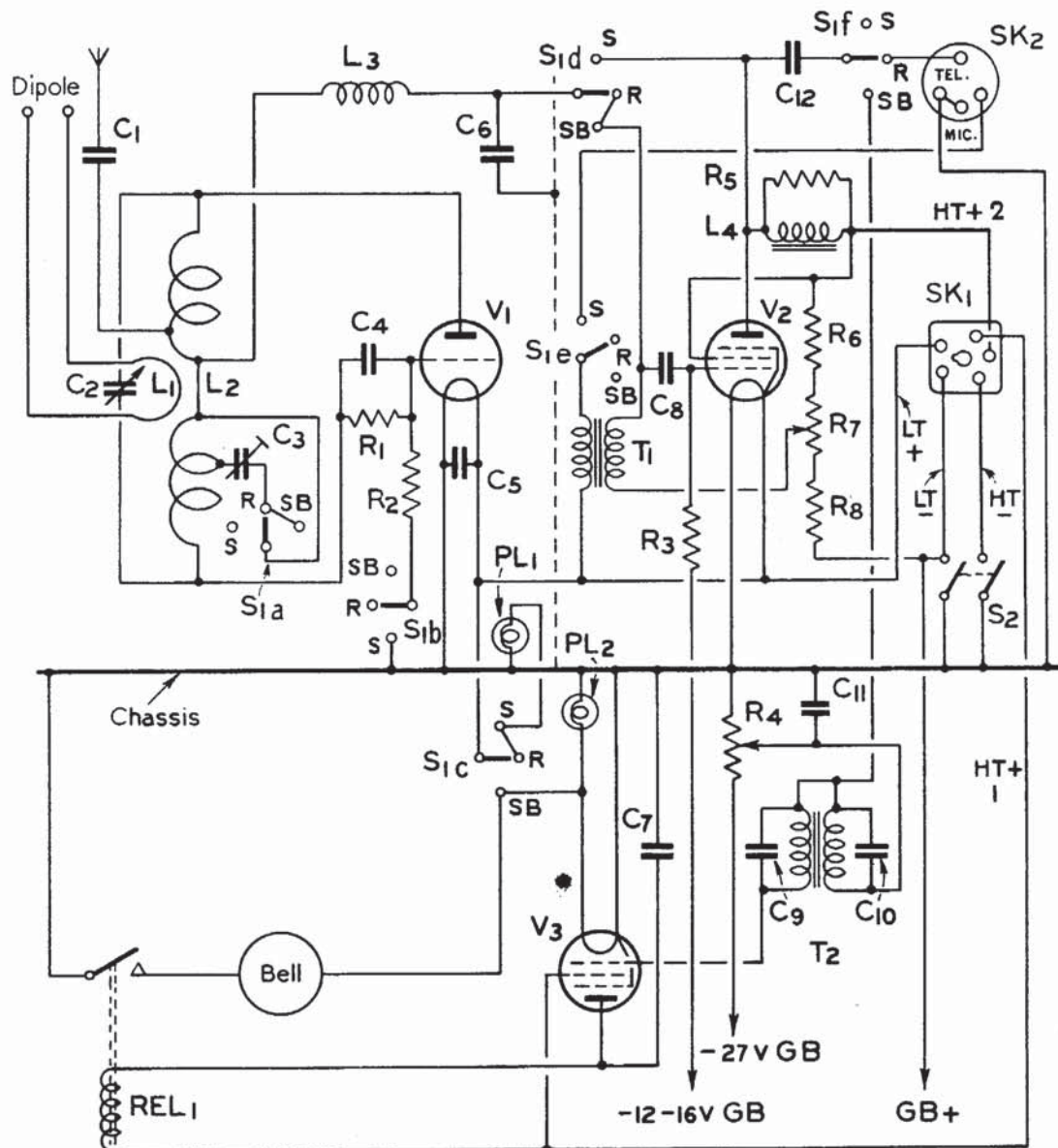


FIG. 1.—TRANSMITTER-RECEIVER T.R.1150



CONDENSERS				RESISTANCES	
C1	0.002 μ F	C9	0.0005 μ F	R1	750,000 Ω
C2	25 μ F Var.	C10	0.002 μ F	R2	10,000 Ω
C3	30 μ F Trimmer.	C11	0.1 μ F	R3	0.5 M Ω
C4	0.0003 μ F	C12	0.01 μ F	R4	100,000 Ω Var.
C5	0.006 μ F			R5	10,000 Ω
C6	0.004 μ F			R6	25,000 Ω
C7	1.0 μ F			R7	50,000 Ω Var.
C8	0.1 μ F			R8	25,000 Ω

T.R. 1150, THEORETICAL CIRCUIT DIAGRAM

FIG. 2

FIG. 2

TRANSMITTER-RECEIVER T.R.1150

(Stores Ref. 10D/78)

INTRODUCTION

1. The T.R.1150 is designed for two-way communication between drifters of Balloon Command over a distance of not more than three miles, and operates on a frequency of 60 Mc/s. The transmitter-receiver, which is portable, derives its power supply from batteries, the accumulator and H.T. battery being carried in an external transit case, whilst the grid bias batteries are fitted inside the instrument.

2. Three valves are employed, two of which are used for transmitting or receiving, and the third, which is introduced into the circuit when standing-by, operates a calling bell by means of a relay.

3. The instrument is housed in a teak cabinet, measuring 16 in. by 10½ in. by 8¾ in., fitted with two hinged doors on the front, a removable back and a leather strap for transit purposes. Space is provided at the bottom for the grid bias batteries and a telephone handset. The case for the accumulator and H.T. batteries is also constructed of teak, and measures 26½ in. by 10½ in. by 12¼ in.

4. Two types of aerials can be utilized. The first, which is a quarter-wave rod type and screws into a bush mounted on the top of the cabinet, is intended for use under conditions where the period of operation is likely to be short and speed of installation is essential; the second, which is a dipole and can be fitted between any two convenient points, should be used where the establishment of the station will be either permanent or cover a period of known duration.

GENERAL DESCRIPTION

5. A theoretical circuit diagram is given in fig. 2, and it will be seen that only the valves V_1 and V_2 are used for transmitting or receiving, according to the position of the SEND/RECEIVE switch S_1 . The valve V_3 is brought into operation in the STAND-BY position of S_1 and is coupled to V_2 . As the anode current rises, the relay REL_1 closes and causes the bell to ring. The valve V_1 is a triode, whilst the other two are pentodes.

Transmit

6. In the SEND position, the dipole aerial inductance L_1 is coupled to the anode of the oscillator valve V_1 via the inductance L_2 , which is tuned by means of the variable condenser C_2 , whilst the rod aerial is connected directly to a tapping point on L_2 through the series condenser C_1 . The bottom end of L_2 is connected to the grid of V_1 via the condenser C_4 , across which is placed the resistance R_1 , whilst R_2 is connected to the chassis by means of section S_{1b} of the SEND-RECEIVE switch, and the pilot light PL_1 is illuminated by section S_{1c} . A R.F. by-pass condenser C_5 is incorporated across the filament of V_1 .

7. The oscillator valve V_1 is modulated in its anode circuit from the valve V_2 , and one end of the primary of the microphone transformer T_1 is switched to the handset socket SK_2 , whilst the other end is connected to L.T. positive, which provides the necessary energizing current for the microphone. The H.T. positive supply to the anode of both valves is fed through the A.F. choke L_4 , across which is the resistance R_5 , the feed to V_1 being obtained through the R.F. choke L_3 , by means of S_{1d} , and by-passed by the condenser C_6 . The supply to the screen-grid of V_2 is drawn directly from the maximum battery voltage, whilst bias is obtained from a separate battery and is applied to the grid through the resistance R_3 .

Receive

8. In this position of the switch S_1 , the valve V_1 functions as a super-regenerative detector and V_2 as an A.F. amplifier. The aerial arrangements remain unchanged, whilst R_2 is disconnected from the chassis by means of S_{1b} , and S_{1a} introduces the trimmer condenser C_3 across a portion of the inductance L_2 . The purpose of this trimmer is for balancing the aerial circuit, in conjunction with the variable condenser C_2 , so that the setting of C_2 remains the same both for transmitting and receiving. This means that two-way communication can be held merely by the movement of the switch S_1 , no adjustment to the tuning being necessary. The output from V_1 is switched, by means of S_{1d} , to the grid of the succeeding valve V_2 via the coupling condenser C_8 , and, at the same time the H.T. supply to the anode of V_1 is fed through the potential divider consisting of the three series resistances R_6 , R_7 and R_8 , the secondary of the microphone transformer T_1 , and the R.F. choke L_3 . Of the three series resistances, R_7 is variable and controls the voltage applied to the anode and consequently the sensitivity of this stage.

9. The H.T. supply to the anode and screen-grid of the valve V_2 remains unchanged, but the output is switched, by means of S_{1f} , through the coupling condenser C_{12} to the handset socket SK_2 and thus to the earpiece. It will be seen that the ON/OFF switch S_2 makes and breaks the connection between the chassis and L.T. negative and H.T. negative.

Stand-by

10. The circuit arrangements of the two valves V_1 and V_2 remain fundamentally the same in this position of the switch S_1 as in the RECEIVE position, the only difference being in the pilot light switching and the introduction of the third valve V_3 , in conjunction with the relay REL_1 and the bell.

11. The L.T. positive feed is removed from the pilot light PL_1 by means of S_{1c} thereby switching it off, and is moved over to PL_2 and the filament of the relay valve V_3 , both of which are then switched on. At the same time one end of the bell induction coil is also connected to the L.T. positive supply, whilst the other end is connected to L.T. negative through the chassis and the ON/OFF switch S_2 .

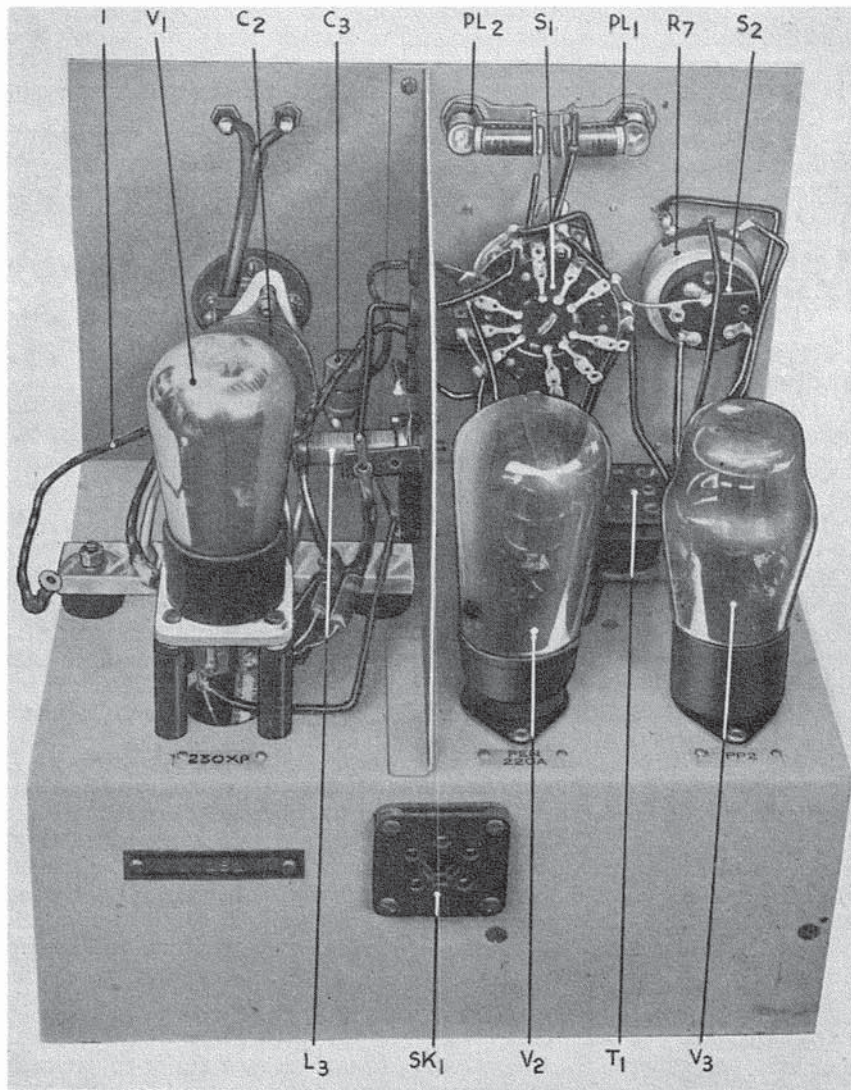


FIG. 3.—TOP OF CHASSIS

12. The output from the valve V_2 is transferred by means of S_{1f} , from the 4-pin socket SK_2 to the grid of V_3 via the inter-valve transformer T_2 , through which bias is applied and the voltage controlled by the variable resistance R_4 . The H.T. supply to the valve is obtained via the socket SK_1 from a tapping point H.T. +1 in the batteries, the feed to the screen-grid being taken direct and that to the anode passing through the coils of the relay REL_1 and by-passed by means of the condenser C_7 . When the bias voltage adjustment has been correctly set by means of the resistance R_4 , so that the relay just remains inoperative, a received signal will produce a rise in anode current, which, passing through the relay coils will cause the relay to operate, thus ringing the bell.

CONSTRUCTIONAL DETAILS

13. A general view of the instrument showing the controls on the front panel is given in fig. 1. the knob (1), which operates the combined variable resistance R_7 and ON/OFF switch S_2 , can be seen in the top left-hand corner, and next to it is the SEND/RECEIVE switch S_1 , with the pilot lights PL_1 and PL_2 above. The two sockets (2) for the dipole aerial are mounted in the right-hand corner of the panel, and the rod aerial screws into the bush (3) on the top of the cabinet. The space at the bottom houses the telephone handset which plugs in to the 4-pin socket SK_2 mounted at the back of the compartment.

14. The control for the tuning condenser C_2 is situated below the dipole sockets, and includes a locking device (4), consisting of a metal ring which screws against the scale plate of the condenser and holds it in position after the correct setting has been obtained. The relay adjustment R_4 is mounted in the bottom right-hand corner, whilst the wire gauze (5) in the opposite left-hand corner allows the ringing of the bell to be heard distinctly.

15. Two further views are given; fig. 3 showing the components mounted on top of the chassis and fig. 4 giving a view of the underside, whilst a bench wiring diagram can be seen in fig. 5. Referring to fig. 3, the valve V_1 and the variable condenser C_2 will be observed in the left-hand compartment together with the trimmer condenser C_3 and R.F. choke L_3 . The lead (1) is the rod type aerial feed, and can be seen disconnected from the bush mounted on top of the cabinet.

16. The valves V_2 and V_3 are situated in the right-hand compartment, also the switch S_1 and the combined variable resistance R_7 and ON/OFF switch S_2 , which are mounted on the front panel. Above these are the two pilot lights PL_1 and PL_2 , whilst the microphone transformer T_1 can be seen below. The 5-pin socket SK_1 on the back of the chassis is for connection to the external accumulator and H.T. supply.

17. The components mounted on the underside of the chassis are shown in fig. 4, the choke L_4 and intervalve transformer T_2 being visible on the left-hand side. The relay REL_1 is mounted on the right-hand side and the relay adjustment control R_4 on the front panel. The screw (2) on the relay is for adjusting the armature gap. The bell (1) is "floated" on rubber, instead of being fitted directly to the chassis, in order to damp out vibration and prevent microphony when it rings.

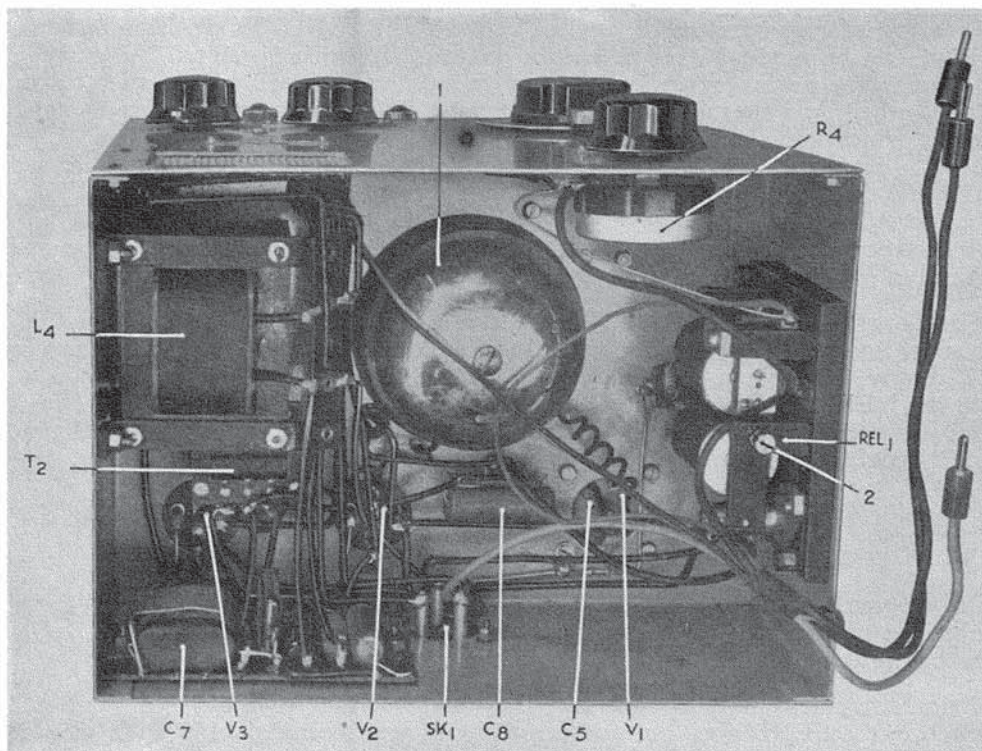


FIG. 4.—UNDERSIDE OF CHASSIS

18. Space is provided in the battery box for the dipole aerial, but the rod type of aerial which consists of four sections of approximately 1 ft. each in length, is carried separately. The sections fit one over the other, and the aerial can be assembled in a matter of a few seconds.

VALVES AND BATTERIES

19. All valves are of the 2-volt filament type, V_1 (Cossor 230 XP) having a consumption of 0.3 ampere, V_2 , V.T.51 (Stores Ref. 10E/10946) a consumption of 0.2 ampere, whilst V_3 (Tungsram PP₂) takes 0.14 ampere. The L.T. supply is obtained from a 2-volt accumulator (Stores Ref. 5A/867) of 90 ampere-hours capacity, and the H.T. supply consists of three 54-volt dry batteries (Stores Ref. 5A/2255) connected up in series. The grid bias is made up of three 9-volt batteries (Stores Ref. 5A/1893) which are also wired in series.

INSTALLATION AND OPERATION

20. First of all remove the back of the cabinet by slackening off the two fixing screws at the top, and make sure that all valves are firmly secured in their correct holders. The aerial may now be connected up to the instrument according to which type is to be used, and the telephone handset plugged into its 4-pin socket in the bottom compartment of the cabinet.

21. After making sure that the instrument is switched off, the grid bias batteries should now be fixed in position underneath the chassis at the back of the cabinet, where a clamping strip for this purpose will be found. The three batteries should be wired up in series and the leads from the chassis, which are marked, connected up accordingly, with G.B.-1 plugged into between 12 and 16 volts and G.B.-2 into the full 27 volts. The back cover can now be replaced and the two fixing screws tightened up.

22. The high and low tension supplies must be connected up next, but before doing so the connections to the accumulator and batteries should be checked. A 5-pin socket will be found on the side of the battery box, with five clearly marked leads attached to it, which can be seen by opening the lid. The three 54-volt batteries must be wired up in series and the leads connected up as indicated, the positions of L.T.—, L.T.+ and H.T.— being obvious, whilst H.T.+1 should be plugged into approximately 100 volts and H.T.+2 into the maximum voltage. The power supply cable can now be connected by plugging one end into the 5-pin socket on the battery box and the other into the similar socket SK₁ on the back of the chassis.

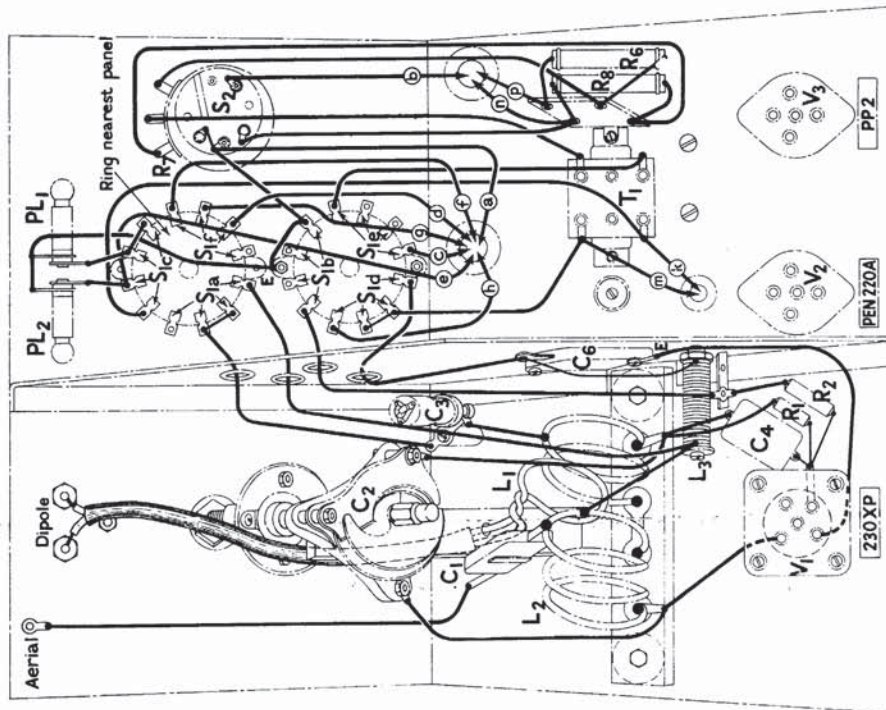
23. The instrument should now be switched on by rotating the SENSITIVITY control (*see* fig. 1) fully clockwise and turning the switch S_1 to the STAND-BY position, when the RELAY ADJUSTMENT can be made. This should be so set that, with no signal being received, the bell just fails to ring on the normal noise level. Any signal now received which is louder than this noise level will ring the bell, and therefore the operator must, to some extent, use his discretion in making the adjustment, since sufficient electrical interference may be caused by some outside source to operate the bell. Experience of the received strength of the transmission will greatly assist, and once the correct setting has been obtained on a permanent site, further alteration should be unnecessary. It must be understood that the bell will not ring continuously once it has started, but will operate only for the duration of the received signal, therefore it may be necessary for the operator to call "Hallo" a number of times until a reply is received.

24. When operating in the RECEIVE position of S_1 , the SENSITIVITY control may require adjustment according to the prevailing noise level conditions, after which two-way communication can be held simply by placing the SEND/RECEIVE switch in the appropriate position. Slight alteration to the RELAY ADJUSTMENT may be found to be necessary. When S_1 is in the SEND or RECEIVE position, the left-hand pilot light PL₁ will be illuminated, and when it is in the STAND-BY position, the right-hand pilot light PL₂ will be lit up and PL₁ switched off.

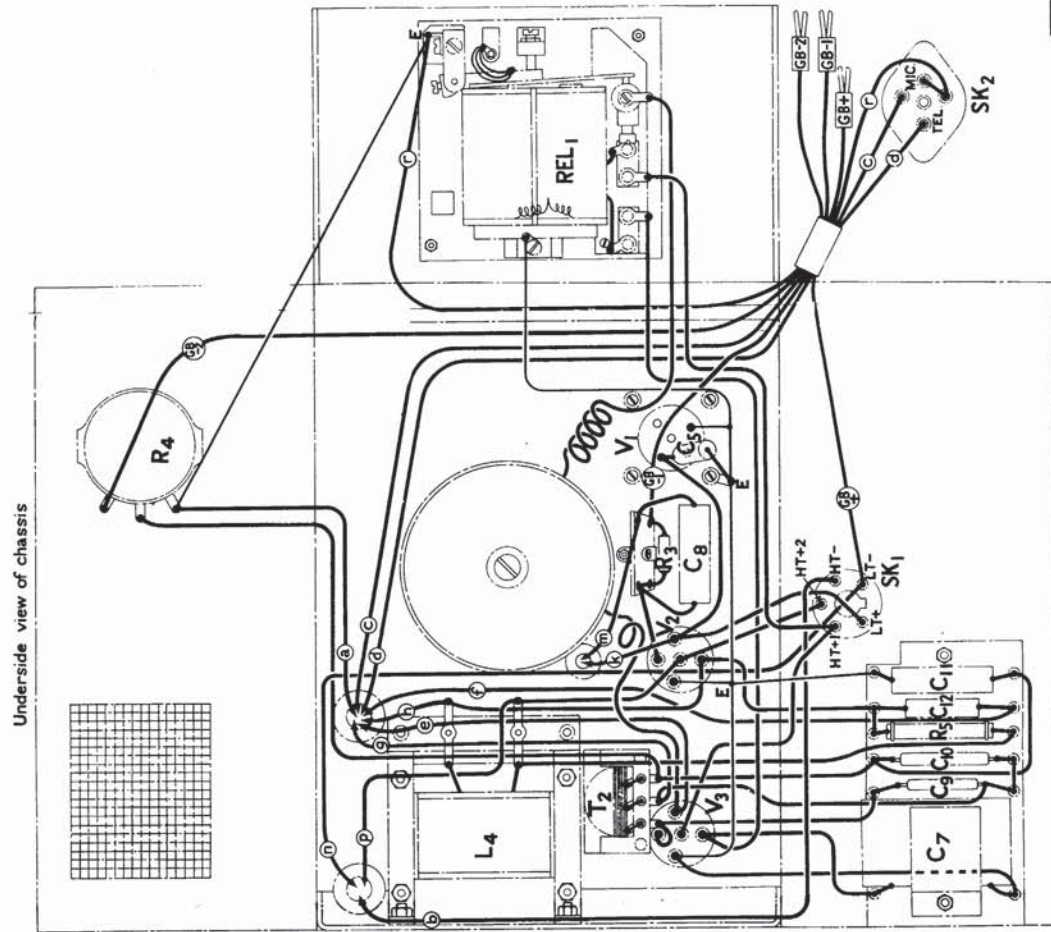
PRECAUTIONS AND MAINTENANCE

25. The accumulator must never be allowed to fall below 1.9 volts on load, and the H.T. batteries should be checked periodically, replacement being made when the voltage drops below 120, whilst the grid bias batteries should be renewed every three months.

26. If the instrument fails to transmit, the anode voltage of the valve V_1 should be checked with the switch in the SEND position, and a reading of approximately 150 volts should be obtained. Next check the H.T. consumption of the two valves V_1 and V_2 , with a milliammeter in the H.T.+2 lead, when a reading of approximately 38 milliamps should be obtained. The aerial should be removed when taking this reading, which will be found to vary with different settings of the tuning condenser C_2 . This variation is evidence that the valve V_1 is oscillating, and if it is prevented from doing so by a fault, the current will rise considerably. As the instrument is adjusted in the first place to transmit and receive on a frequency of 60 Mc/s, a careful note of the exact scale setting of C_2 should be made before the locking device is loosened and the condenser rotated.



T.R.1150, BENCH WIRING DIAGRAM



27. A test for the radiation of R.F. energy can be made by inserting between the turns of the inductance L_2 , a loop of wire approximately one inch in diameter with a 3.5-volt, 0.3-amp. bulb in series with the ends, and a glow from the bulb will indicate whether radiation is taking place. Stiff covered wire should be used, and the device supported on a strip of insulating material.

28. If trouble is experienced when receiving, a voltage test should be carried out with the switch in the RECEIVE position, and a reading of approximately 150 should be obtained on the anode and screen of the valve V_2 , whilst the anode volts of V_1 should vary between 16 with the SENSITIVITY control at minimum and 40 at maximum. The H.T. consumption of the two valves may be checked and should be approximately 18 milliamps.

29. In the case of the relay failing to close, the H.T. on the anode of the valve V_3 may be tested and should be approximately 90 volts with 100 volts on the screen. The H.T. current drawn by V_3 , and flowing through the relay coils can be ascertained by removing the two valves V_1 and V_2 from their holders, and inserting a milliammeter in the H.T. +1 lead. This current will vary with different positions of the RELAY ADJUSTMENT, from 0 with the control turned fully clockwise to 17 milliamps turned fully counter-clockwise. The armature gap adjustment provided on the relay itself, should be set to close at from 3 to 5 milliamps. It is possible that the bell may fail to ring owing to the hammer jamming against the stop inside or to seizing of the armature contacts and examination with the gong removed will indicate the fault.

30. Inspection should be made to ensure that all valve pins are a good fit in their respective holders, switch contacts are making properly, plugs fixed securely to the end of their leads and all wires firmly soldered in position. When taking voltage and current consumption readings, it is very important to make sure that the accumulator, H.T. and grid bias batteries are in good condition.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. When ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/78	Transmitter-receiver, type T.R.1150			
	Principal components:—			
10D/123	Bell			
10D/152	Bush, aerial, connecting	1		
10C/400	Choke, A.F., type 38	1	L ₄	
10C/401	Choke, R.F., type 66	1	L ₃	
	Condenser			
10C/426	Type 697	1	C ₇	1 μ F
10C/512	Type 744	3	C ₈ , C ₁₁ , C ₁₃	0.1 μ F
10C/513	Type 745	1	C ₉	0.0005 μ F
10C/429	Type 700	2	C ₁ , C ₁₀	0.002 μ F
10C/514	Type 746	1	C ₁₂	0.01 μ F
10C/516	Type 748	1	C ₂	25 μ F, variable
10C/517	Type 749	1	C ₅	0.006 μ F
10C/518	Type 750	1	C ₆	0.004 μ F
		1	C ₄	0.0003 μ F
10C/504	Type 751	1	C ₃	30 μ F, trimmer
10D/153	Coupler	1		Flexible
10D/151	Coupling, unit, type 8	1	L ₂	Coil assembly
	Holder, valve			
10H/303	Type 46	2		5-pin
10H/304	Type 47	1		4-pin
	Knob			
10A/12074	Type 22	3		12-sided, black
10A/12075	Type 23	1		Tuning, engraved 0–100
10A/12133	Lampholder, type 8	2		
10F/144	Relay, magnetic, type 83	1	REL ₁	
	Resistance			
10C/525	Type 796	1	R ₄	100,000 ohms variable
10C/27	Type 544	2	R ₂ , R ₅	10,000 ohms
10C/526	Type 797	1	R ₇	50,000 ohms variable, with double switch
10C/527	Type 798	2	R ₆ , R ₈	25,000 ohms
		1	R ₁	0.75 M ohms
10C/528	Type 799	1	R ₃	0.5 M ohms
	Sockets			
10H/211	Type 99	1	SK ₁	5-pin battery
10H/278	Type 117	2		
10F/143	Switch, type 229	1	S ₁	2-bank, 3-pole, 3-way
	Transformer			
10K/12134	Type 128	1	T ₂	Intervalve
10K/12135	Type 129	1	T ₁	Microphone
	Accessories:—			
5A/867	Accumulator, No. 1, Mk. 4	1		2-volt, 90 ampere-hours
5A/1893	Batteries, dry, 9-volt	3		Grid bias
5A/2255	Batteries, dry, 54-volt	3		High tension
10D/88	Case, transit, battery	1		
10H/212	Connector, type 186	1		5-way battery, fitted with plugs, type 163
10B/287	Dipole, aerial	1		
10A/12033	Head set, combined type 1			
5A/361	Lamps, filament	2	PL ₁ , PL ₂	3.5 volts
	Plug			
10H/214	Type 165	2		Single-pole, red
10H/215	Type 164	2		Single-pole, black
10H/216	Type 166	1		Single-pole, engraved —1
10H/217	Type 167	1		Single-pole, engraved —2

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver, type T.R.1150— <i>contd.</i> Accessories— <i>contd.</i> Plug— <i>contd.</i>			
10H/218	Type 168	1		Single-pole
10H/213	Type 163	2		5-pole
10H/223	Type 169	1		4-pole
10B/286	Rod, aerial, type 9	1		
10H/211	Socket, type 99	1		5-pin
	Valve (Cossor 230 XP)	1	V ₁	
	(Tungsram PP2)	1	V ₃	
10E/10946	Type V.T.51	1	V ₂	

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SECTION 2, CHAPTER 8

TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A

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CONCISE DETAILS OF **TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A**

PURPOSE OF EQUIPMENT	Airborne equipment designed primarily for F.A.A. It may be applied to multi-seater aeroplanes by incorporating amplifier A.1134 or other suitable instrument. Embodies transmitter unit, type 22, receiving unit, type 25, either chassis assembly, type 7 with power unit, type 87, or chassis assembly, type 8, with power unit, type 104.		
TYPE OF WAVE	R/T and M.C.W.		
FREQUENCY RANGE ...	4.3 Mc/s to 6.7 Mc/s in maximum of four "spot" frequency channels.		
FREQUENCY STABILITY ...	Quartz crystal controlled.		
CRYSTAL MULT. FACTOR ...	Fundamental operation in transmitter, type 22. Plus or minus 460 kc/s off frequency channel in the super-heterodyne receiver, type 25, for local oscillator.		
PERCENTAGE MODULATION	100 per cent.		
MAXIMUM SENSITIVITY ...	Input of 10 micro-volts modulated 50 per cent. at 1,000 c/s—output 40 to 60 milliwatts into 20,000 ohms. Less than 10 per cent distortion for output of 140 milliwatts into 8,000 ohms, that is, 3 pairs of telephones.		
SELECTIVITY	6 kc/s bandwidth for 6 db attenuation. 30 kc/s bandwidth for 40 db attenuation.		
OUTPUT IMPEDANCE ...	50 ohms for 3 pairs of 150 ohms telephones 200 ohms for 3 pairs of 600 ohms telephones 8,000 ohms for 3 pairs of 20,000 ohms telephones } Regulation assisted by negative feedback to prevent excessive rise with fewer telephones in use.		
AMPLIFIER CLASS	Class C in transmitter output stage, anode modulated.		
MICROPHONE TYPE ...	Electro-magnetic, type 21 or type 26 (Stores Ref.—10A/11994 and 10A/12571).		
VALVES	<i>Transmitter unit, type 22.</i> Crystal-controlled oscillator pentode V. R. 91 (Stores Ref.—10E/92). Output tetrode, V.T.501 (Stores Ref.—10E/389). Modulator pentode V.T.52 (Stores Ref.—10E/11398). <i>Receiving unit, type 25.</i> R.F. and I.F. pentodes V.R. 53 (Stores Ref.—10E/11399). Frequency-changer octode V.R.57 (Stores Ref.—10E/11403). A.G.C. first A.F. and microphone amplifier pentode, V. R. 56 (Stores Ref.—10E/11402). Double diode-triode output and 2nd microphone amplifier V.R. 55 (Stores Ref.—10E/11401).		
POWER INPUT	<i>Transmitter</i> 250 volts, 60 mA, H.T.; 6.3 volts, 1.3 amp.; heaters. <i>Receiver</i> 275 volts, 35 mA, H.T.; 6.3 volts, 1.2 amp.; heaters. <i>Total input</i> from aeroplane supply to rotary transformer—5 amps. at 13 volts or 2.5 amps. at 26 volts.		
POWER OUTPUT	0.4 amp. to 0.6 amp. into "small" (100 μ F) type aerials as used with transmitter-receivers T.R.9D and T.R.9F. Given resistance 5 ohms, power is between 0.8 watts and 1.8 watts.		
STORES REF. No.	T.R.1196, 10D/325; T.R.1196A, 10D/369.		
APPROXIMATE OVERALL DIMENSIONS.	LENGTH 18 in. WIDTH 11 in. HEIGHT 7½ in. Fixing centres in base identical with T.R.1133 and T.R.1143.		
WEIGHT	36 lb. including cables and the controller, electric, type 4.		
ASSOCIATED EQUIPMENT...	Controller, electric, type 4 (Stores Ref.—10J/22). Crystal unit, type A, 8 off (Stores Ref.—10X/ as required). Connector set, type according to installation. Amplifier A.1134, (certain installations Stores Ref.—10U/1150). Receiver telephone, head, type 32, 150-ohm impedance (Stores Ref.—10A/13466). Receiver telephone, head, types 16, 17, or type C, 20,000 ohm-impedance (Stores Ref.—10A/8543). 600-ohm impedance telephones, types unspecified (U.S.A.). Contact cleaner (Stores Ref.—1H/6).		

TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A

(Stores Ref. 10D/325 and Stores Ref. 10D/369)

INTRODUCTION

1. The transmitter receivers T.R.1196 and T.R.1196A are multiple channel R/T and M.C.W. instruments operating on fixed frequencies in the band from 4.3 Mc/s to 6.7 Mc/s and are designed for use in aircraft. A maximum of four "spot" frequencies may be preset prior to flight. Stabilization of frequency by quartz crystal-control is provided in the transmitter and receiver.

2. The transmitter receiver is intended to be worked into a short capacitive aerial ($100\mu\text{F}$) of a maximum length of 28 ft. giving a telephony air-to-ground range of 50 miles at an altitude of 2,000 ft., with an air to air range of 30 miles. When used in certain types of aircraft it may be necessary to load the aerial either inductively or capacitatively in order to cover the specified band of frequencies.

3. A push button remote control unit affords facilities for the frequency selection in flight. In addition, the controller incorporates a three-way key switch for TRANSMIT RECEIVE-RECEIVER ATTENUATION, an OFF button and a two pin socket for a PRESS-TO-TRANSMIT plug, if desired, to override the TRANSMIT switch. The receiver attenuation is variable and is used to reduce, up to a maximum of 20 db, in the absence of a signal.

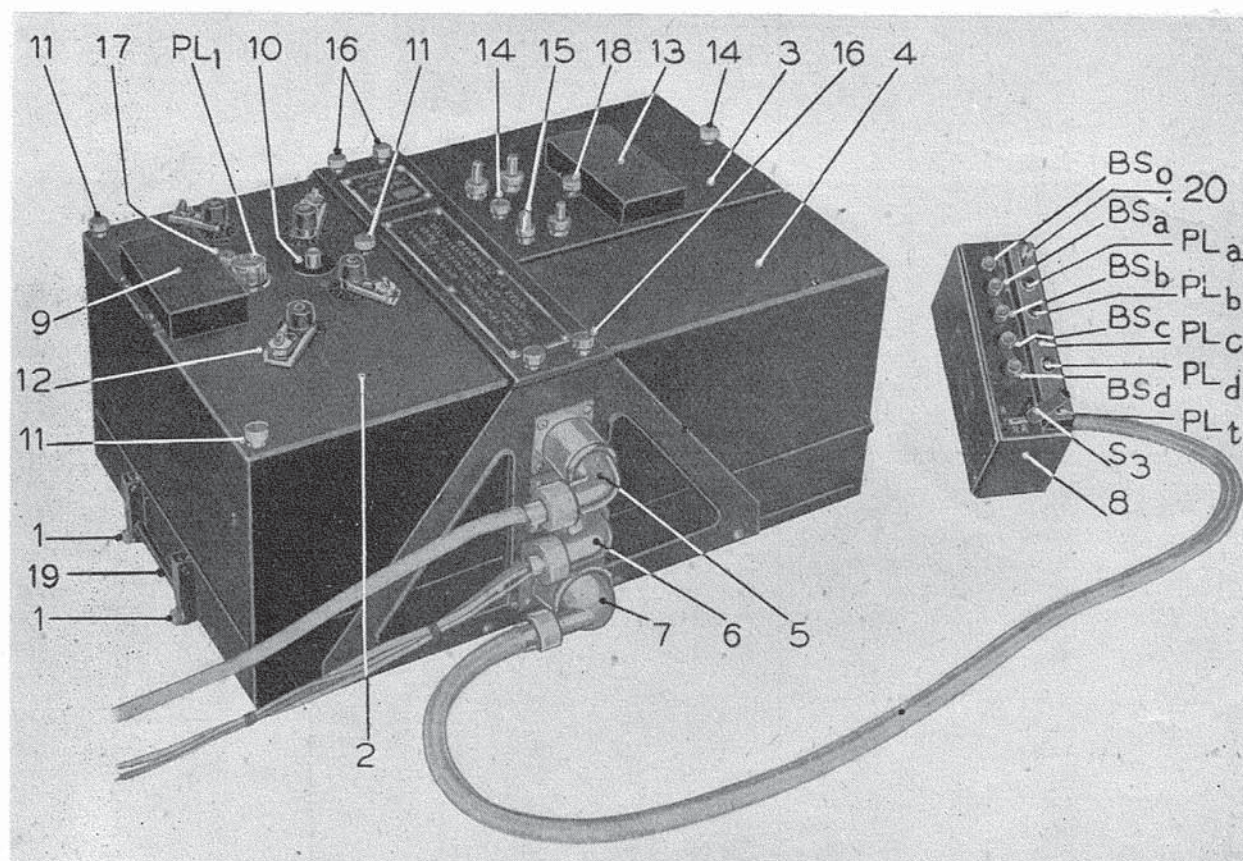


FIG. 1.—THE TRANSMITTER-RECEIVER T.R.1196 WITH THE CONTROLLER, ELECTRIC, TYPE 4

4. The transmitter receivers each consist of a main mounting chassis carrying three quickly detachable units which are—the transmitter unit, type 22, the receiving unit, type 25 and either the power unit, type 87 (24-volt), or the power unit, type 104 (12-volt). The former power unit forms part of the T.R.1196 and the latter of the T.R.1196A. The transmitter and receiver units for the two types are identical. The main mounting chassis has a transverse centre section carrying all plugs and sockets required for connexion between units and to external apparatus. For the T.R.1196 this is the chassis assembly, type 7 (24-volt) and for the T.R.1196A, the 12-volt assembly, type 8.

5. The transmitter circuit consists of a crystal controlled oscillator pentode stage, working on the crystal fundamental frequency, a modulator pentode stage and a R.F. amplifier tetrode stage. The transmitter output circuits are used as input tuned circuits for the receiver. A key operated relay transforms the modulator to a selective positive feed back oscillator for tone modulation.

6. The receiver circuit comprises a variable- μ pentode R.F. amplifier, an octode frequency-changer amplifier, the triode portion of which acts as a local oscillator, crystal controlled, a variable- μ pentode intermediate frequency amplifier at a frequency of 460 kc/s, a pentode automatic gain control (A.G.C.) amplifier, a pentode first A.F. amplifier and a double-diode-triode output stage. The A.F. stages of the receiver are also used as a microphone amplifier to provide sub-modulation of the transmitter and I/C by electro-magnetic microphones, type 21 or type 26 used at three positions in the aircraft. Where an increased number of positions is required to be served, the amplifier A.1134, or other suitable instrument, may be used as an alternative I/C amplifier. Slight link changes permit the use of 150-ohm, 600-ohm, or 20,000-ohm impedance telephones.

7. The power supplies for the transmitter-receiver are derived from a power unit incorporating a three commutator rotary transformer with input and output smoothing components. The power unit, type 87, has a nominal 24-volt input and the power unit, type 104, an input of 12-volts nominal. The input to the power unit is derived from the aircraft general electrical system. The power output into "small" or 100 μ F (of the order of 28 ft.) aerials will be approximately 0.8 to 1.8 watts.

8. The general appearance of the transmitter-receiver together with the control unit, and the leads to the aircraft electrical supply, microphone and telephone is shown in fig. 1. The overall dimensions of the complete instrument are, approximately, 18 in. wide by 7½ in. high by 11 in. deep and the total weight including the controller electric, type 4, but without cables, is approximately 40 lb.

GENERAL DESCRIPTION

The transmitter unit, type 22

9. A theoretical circuit diagram of the transmitter unit, type 22, is given in fig. 2. An indirectly-heated pentode valve V_1 , is connected as a cathode-coupled oscillator, the frequency of which is determined by one of four quartz crystals X_a , X_b , X_c or X_d .

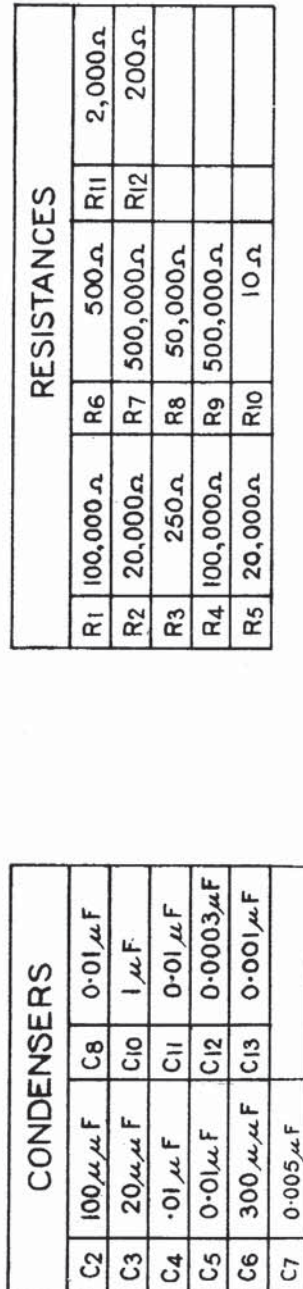
10. A cathode bias resistance R_3 provides for an initial negative biasing of the valve. A choke L_1 prevents the crystal from being short-circuited at radio frequency. The series condensers C_3 and C_2 constitute the grid to earth capacitance for the valve V_1 . A regenerative effect is introduced to the cathode through the junction of C_2 and C_3 and is determined by the value of C_2 . A resistance R_1 is a grid leak and a resistance R_{12} is an anti-parasitic resistance in the grid circuit.

11. The screen voltage for V_1 is reduced to a suitable value by a resistance R_2 , the necessary decoupling to earth being brought about by a condenser C_4 . The anode voltage is fed through an anode load coil L_2 the H.T. line being decoupled by a condenser C_5 .

12. The coupling between the valve V_1 and an amplifying tetrode valve V_2 is *via* the anode coil L_2 and a grid coil L_3 , the combination affording a band-pass arrangement having a sufficiently wide characteristic to accommodate the whole range of frequencies operated. This design consideration obviates the use of four separate tuned anode circuits for V_1 and an adequate drive voltage is supplied to the grid of V_2 between the frequency limits of 4.3 Mc/s and 6.7 Mc/s.

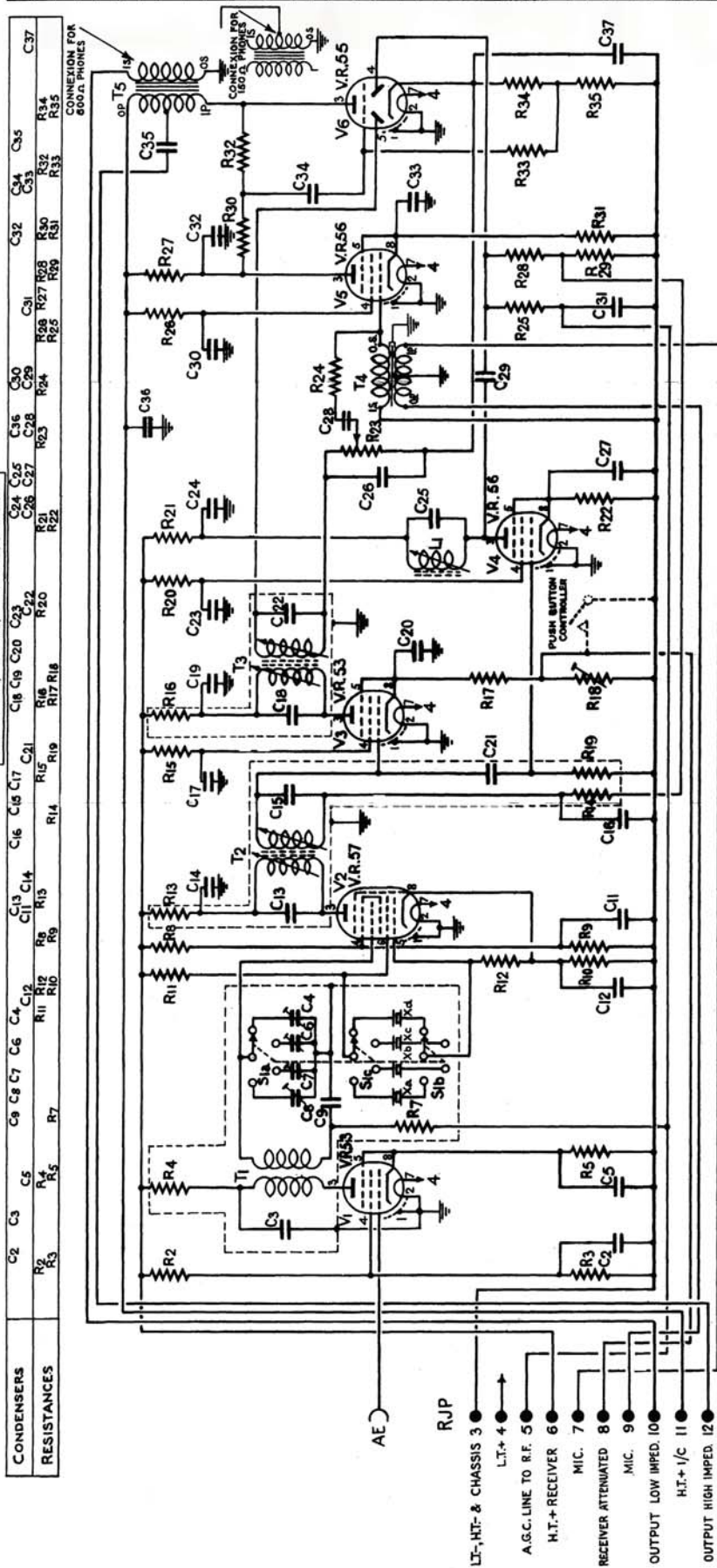
13. Higher power conversion efficiency is obtained by operating the valve V_2 as a class C amplifier. Sufficient anode-grid capacitance exists in V_2 to make it desirable to provide for some degree of neutralization under the variable drive conditions. This is provided by a single turn loop L_9 used between the lower ends of the coils L_5 , L_6 , L_7 and L_8 and earth and coupled inductively to the secondary winding L_3 , of the R.F. transformer. Satisfactory modulation is given at all frequencies at which the grid drive exceeds, approximately, 40 volts peak, a bias of 40 volts being approximately twice the cut-off bias at normal anode and screen voltages. Any reduction in the grid drive volts will cause the valve to operate less efficiently and not under the class C condition required. A complete discussion of class C operation can be found in A.P.1093, Chapters IX and XI. Grid bias is provided by a self-bias resistance R_4 which acts as a leak in the grid-rectification system constituted by R_4 and C_6 .

14. To provide for efficient power transference between the amplifier output and the aerial circuit four preset coils L_5 , L_6 , L_7 and L_8 are provided. These are coils of the continuously variable type and the shunt capacitance for each is, in effect, represented almost entirely by the aerial system. The coils L_5 , L_6 , L_7 and L_8 are selected by a 2-bank switch ganged to a further bank which selects the appropriate crystal. The crystal selector portion is S_{1a} , the anode end selector for the coils, S_{1b} , and the Ae tap end selector S_{1c} . The aerial current is normally between 0.4 amp. and 0.6 amp.



THE TRANSMITTER UNIT, TYPE 22, CIRCUIT DIAGRAM

A.P. 1186, VOL. I, SECT. 2, CHAP. 8



THE RECEIVING UNIT, TYPE 25. CIRCUIT DIAGRAM

FIG. 3

CONDENSERS	RESISTANCES
C2 0.01μF	R2 0.1MΩ
C3 0.01μF	R3 0.2MΩ
C4 100μμF	R4 2000Ω
C5 0.01μF	R5 400Ω
C6 100μμF	R7 0.1MΩ
C7 100μμF	R8 0.1MΩ
C8 100μμF	R9 0.1MΩ
C9 0.01μF	R10 400Ω
C11 0.01μF	R11 50,000Ω
C12 0.1μF	R12 50,000Ω
C13 150μμF	R13 2,000Ω
C14 0.1μF	R14 1MΩ
C15 150μμF	R15 0.1MΩ
C16 0.1μF	R16 2,000Ω
C17 0.1μF	R17 200Ω
C18 150μμF	R18 5,000Ω
C19 0.1μF	R19 0.5MΩ
C20 0.1μF	R20 0.2MΩ
C21 100μμF	R21 5,000Ω
C22 150μμF	R22 500Ω
C23 0.1μF	R23 0.5MΩ
C24 0.1μF	R24 0.5MΩ
C25 200μμF	R25 1MΩ
C26 200μμF	R26 0.25MΩ
C27 0.1μF	R27 60,000Ω
C28 0.01μF	R28 1MΩ
C29 100μμF	R29 0.25MΩ
C30 0.1μF	R30 0.1MΩ
C31 0.1μF	R31 600Ω
C32 500μμF	R32 0.5MΩ
C33 0.1μF	R33 1MΩ
C34 0.01μF	R34 600Ω
C35 0.5μF	R35 600Ω
C36 0.1μF	R36 0.1μF
C37 2μF	R37 2μF

FIG. 3

15. An aerial circuit resonance indicator consists of a pilot lamp PL₁. The pilot lamp is shunted by a resistance R₁₀ and is brought into operation by a plunger-operated break switch, S₂. The coupling condenser C₁₃ affords the necessary blocking for H.T.

16. To the control grid of a pentode valve V₃, a sub-modulation input is applied from the receiver A.F. stages *via* a resistance R₈. When using R/T the contacts A.2 of a magnetic relay REL $\frac{A}{2}$ complete a negative feedback channel from the anode of V₃ through a condenser C₁₁ and a resistance R₇. In order to obviate any tendency to self-oscillation in the final valve of the receiver, due to the interlocking of the circuit with this stage of the transmitter, a resistance R₁₁ is included between the top end of R₈ and the modulation input from the receiver at the TJP₄ point of the transmitter Jones plug TJP.

17. To provide a tone modulation for M.C.W., when keying the transmitter, the valve V₃ is arranged as a selective positive feedback oscillator, the feedback voltage being obtained from a special winding "c" on a modulation transformer T₁, the modulation frequency being determined by the constants of a resistance R₉, the inductance of the winding "c" and a condenser C₁₂. The modulation transformer T₁ has a ratio of 1 to 1.25 (winding "b" to winding "a") and through it the output from the anode of V₃ is applied to the anode and screen of the valve V₂.

18. The simultaneous modulation of anode and screen of V₂ in the system employed provides for a more approximately linear modulation by maintaining a constant ratio of voltage between the two electrodes. Two R.F. by-pass condensers C₇ and C₈, in series, form a potential divider, feeding the screen. The values of C₇ and C₈ are so chosen that they maintain the correct voltage ratio at all modulating frequencies.

19. When the key is closed the supply circuit to the magnetizing coil of the relay REL $\frac{A}{2}$ is completed and the negative feedback circuit through C₁₁ and R₇ is broken. This provides for 100 per cent. modulation of from 800 to 1,500 c/s. Connexion to the chassis assembly is made by two plugs, Ae for the aerial and TJP, the transmitter Jones plug, consisting of six points — TJP₁ for L.T. negative, H.T. negative and earth; TJP₂ for L.T. positive; TJP₃ for M.C.W. relay REL $\frac{A}{2}$ negative; TJP₄ for modulation input from receiver; TJP₅ for H.T. positive and TJP₆ for relay REL $\frac{A}{2}$ positive.

The receiving unit, type 25

20. The circuit of the receiving unit, type 25, is of the super-heterodyne type and is shown in fig. 3. The R.F. input to the control grid of an indirectly-heated pentode valve V₁ is capacitance-coupled by a small condenser C₁ which is included in the chassis assembly unit. A resistance R₁, also in the chassis assembly unit, applies the automatic gain control for the stage V₁. The grid circuit tuning of this stage utilizes the transmitter output coils L₅, L₆, L₇ and L₈, which are continuously variable and are adjusted to resonance with the individual channel crystals employed in the transmitter.

21. A screen H.T. dropping resistance is R₂. A similar function for the anode is performed by a resistance R₄ incorporated in the screened container for a R.F. transformer T₁. The output of V₁ is inductively coupled by the transformer T₁ to the control grid of the pentode portion of an octode valve V₂. The cathode circuit includes a fixed bias resistance R₅ and a by-pass condenser, C₅. The valve V₁ has a variable- μ characteristic and this R.F. amplifying stage results in a reduction in noise level and an improvement in image ratio.

22. The secondary winding of the transformer T₁ is tuned by a preset condenser as selected by a bank S_{1a} of a four-way switch S₁. The condenser is C₄, C₆, C₇ or C₈, according to the particular "spot" frequency, coded A, B, C or D, selected. The theoretical considerations involved in the choice of "tuned secondary" circuit in preference to the tuned anode or "tuned primary" methods of R.F. inter-valve coupling can be found, together with the relevant mathematical treatment, in A.P.1093, Chapter XI.

23. The input to the control grid of the pentode portion of the frequency changer-amplifier valve V₂ is mixed with a local oscillator voltage derived from the triode constituted by the common cathode 8, control grid 5 and grid 6, which, is, virtually, the anode for the oscillator. The H.T. voltage dropping resistance for the pentode anode 3, is R₁₃, for the screen, R₈; the A.V.C. bias resistance is R₇. The H.T. voltage for the oscillator grid 6 is dropped by R₁₁ the value of which is sufficiently high to obviate the necessity for a R.F. choke. The bias for the cathode 8 is fixed by R₁₀ and R₁₂ is a grid leak from grid 5.

24. The frequency of the local oscillator component is determined by the fundamental frequency of a quartz crystal which, selected by a bank of the four-way switch S₁, is connected between the grid 6 and the grid 5. This oscillator is, in effect, a conventional anode-to-grid crystal oscillator

in which the crystals X_a , X_b , X_c or X_d are substituted for the tuned anode circuit. Oscillator feedback is derived from grid-to-cathode capacitance of the valve. A condenser C_{12} decouples the cathode circuit for the I.F. voltages.

25. The local oscillations are electronically-coupled to the input signal within V_2 and frequency changing to 460 kc/s is effected. The two frequencies "beat" at 460 kc/s and, due to the non-linear action of the stage, voltages at the beat frequency appear in the anode circuit. As an example, if the received signal frequency, for which the instrument is tuned, is 5,500 kc/s, the receiver local oscillator crystal employed would have a fundamental frequency of either 5,040 kc/s or 5,960 kc/s, that is, differing from the input frequency by plus or minus 460 kc/s.

26. The amplified I.F. output from the anode 3 of the valve V_2 is coupled to the control grid of a subsequent pentode valve V_3 by a R.F. transformer T_2 . The windings of T_2 are designed to give optimum coupling, and, in practice, bring about an attenuation, by 3 db, of signals plus or minus 3.0 kc/s removed from the I.F. and of 20 db for a total bandwidth of 30 kc/s (plus or minus 15 kc/s.). For the complete I.F. amplifier, incorporating two such transformers, the attenuation figures are 40db for 30 kc/s and 6 db for 6 kc/s total band width. The windings of T_2 are tuned by screwdriver adjustment of the iron dust cores and both are shunted by condensers, C_{13} and C_{15} , which are of equal capacitance. The anode resistance for the amplifier portion of V_2 is R_{13} , the circuit being by-passed by a condenser C_{14} . The resistance R_{13} , a filter resistance R_{14} (see para. 38) with a grid coupling condenser C_{21} and resistance R_{19} , are contained within the screening can of the transformer T_2 .

27. The valve V_3 is a variable- μ pentode. Coupling between V_3 and the succeeding stage, which is the diode portion of the double-diode-triode valve V_6 , is by means of a R.F. transformer T_3 , similar in characteristic to the transformer T_2 . The anode resistance for V_3 is R_{16} which is contained in the screening can of the transformer, the H.T. being by-passed by a condenser C_{19} . Cathode bias to V_3 is fixed by a resistance R_{17} or a conjunction of R_{17} with a series variable resistance R_{18} as will be explained in para. 39. The screen voltage is reduced by a resistance R_{15} and by-passed by a condenser C_{17} . The cathode suppressor grid circuit is by-passed by C_{20} .

28. The signal voltage across the secondary of T_3 is injected at the first diode 5 of the valve V_6 and is rectified by the diode portion, the resultant A.F. component appearing across a load resistance R_{23} . This resistance is a preset potentiometer and is shunted by a condenser C_{26} . The audio voltages developed across R_{23} are coupled, through a resistance R_{24} , to the control grid of a first A.F. pentode valve V_5 . The resistance R_{24} and a condenser C_{28} constitute part of the A.C. load of the valve V_5 , the condenser C_{28} isolating the biasing system of V_5 from that of V_6 . The secondary winding of the microphone transformer T_3 is connected between the grid of V_5 and earth.

29. The microphone is approximately matched to R_{24} by the transformer T_4 and the microphone terminals RJP₇ and RJP₉ of the receiver Jones plug RJP, provide receiver output at microphone level when a separate I/C amplifier is used. It is therefore possible to connect a suitable amplifier, such as the A.1134, to these terminals providing radio signals at an increased number of positions without risk of any undesirable interaction effects due to the output circuit of the receiver and of the amplifier being common.

30. The valve V_5 is cathode biased by a resistance R_{31} by-passed by a condenser C_{33} . The screen H.T. dropping resistance is R_{26} and, for the anode, R_{27} . The function of V_5 , as an A.F. amplifier for receiver signals, is supplemented by its use as a microphone amplifier, the microphone input being provided at terminals RJSK₉ and RJSK₇ in the chassis assembly.

31. The valve V_5 is resistance-capacitance coupled to the output A.F. amplifier, which is the triode portion of the double-diode-triode V_6 , through a resistance R_{30} , a condenser C_{34} , and a grid leak resistance R_{33} . The grid leak R_{33} is returned to a tapping on the output valve bias resistance constituted by R_{34} and R_{35} . Cathode bias is fixed by a resistance R_{34} and a condenser C_{37} decouples the system.

32. A condenser C_{32} , shunted across the anode-to-earth voltages of the valve V_5 , serves to attenuate the higher audio frequencies. Negative voltage feedback is provided in this final amplifier stage by a resistance R_{32} and this is injected in opposition to the voltage from V_5 through the grid condenser C_{34} . Partial compensation for the varying load conditions brought about by the connexion of more than one pair of telephones is, by means of this feedback, rendered possible, the A.F. output voltage remaining reasonably constant.

33. An output transformer T_5 has a tapped primary and, in conjunction with a condenser C_{35} , this provides for high impedance telephones and for modulation. The secondary winding of T_5 is an alternative output to be used, as a whole, with 600-ohm impedance telephones; a tapping on this secondary winding can be used to accommodate telephones of 150-ohm impedance. The output impedance for maximum undistorted output rates at 50 ohms for three pairs of 150-ohm telephones, at 200 ohms for three pairs of 600-ohm telephones and at 8,000 ohms for the same number of 20,000-ohm telephones.

34. The utilization of the stages V_5 and V_6 in the dual capacity of receiver A.F. amplifier and sub-modulator for the transmitter, necessitated independent H.T. positive circuits for R.F. and A.F. supply. When the A.F. portion of the receiver is used with the microphone the R.F. H.T. supply is switched out of circuit through the action of a TRANSMIT-RECEIVE relay in the chassis assembly, this relay being, in turn, governed by the T/RA/R key switch in the controller unit.

Automatic gain control

35. In order to avoid the necessity for the remote means of controlling volume, amplified delayed A.G.C. has been included in the design. In conjunction with the negative feedback applied to the stages V_5 and V_6 a level output of plus or minus 4 db. is maintained with signal variations of from 5 microvolts to 100 millivolts and load variations from one to three pairs of telephones.

36. A portion of the I.F. signal appearing across the secondary of T_2 is coupled, through a condenser C_{21} , to the control grid of a pentode valve V_4 which is the A.G.C. amplifier. An amplified signal appears across a resonant circuit comprising an adjustable iron dust core coil L_1 and a condenser C_{25} . This circuit is tuned to the I.F. of 460 kc/s and the LC ratio is so adjusted that possible variations in the anode to earth capacitance of the valves used for the V_4 stage are compensated. This compensation is effected by arranging that the shunt condenser C_{25} , for L_1 , has twice the capacitance of similarly employed condensers for the secondary windings of T_2 and T_3 respectively, the inductance of L_1 accordingly being halved.

37. The amplified I.F. signal across L_1 is applied *via* a condenser C_{29} to the second diode (4) of the valve V_6 and rectification takes place, the resultant D.C. component appearing across a load resistance constituted by R_{28} and R_{29} in series. This rectifying action is, however, delayed until the peak voltage on the second diode exceeds the delay voltage of approximately 10 volts. This delay voltage is due to the voltage drop across the series resistance R_{34} and R_{35} and is produced by the triode anode current of V_6 . The receiver remains at full gain until the carrier signal strength approaches 5 microvolts, while from 10 microvolts upwards the output is kept practically constant. A block schematic diagram showing the interdependence of the transmitter and receiver and embodying the A.G.C. system is given in fig. 4.

38. If the A.G.C. voltage were applied only to the R.F. and frequency changer stages an inadequate degree of control would be obtained. The use of a separate A.G.C. amplifier, however, renders it possible to control the I.F. amplifier which is situated at a point in the network at which the control voltage is tapped off. This point is selected in such a way that an almost level characteristic is obtained. This condition is brought about by applying half the D.C. control voltage to V_3 from the potential divider R_{28} , R_{29} . The bias for the stage V_3 is taken in a series feed circuit from the junction of R_{28} and R_{29} , through a filter circuit consisting of R_{14} and C_{16} , to the secondary of T_2 and thence to the grid of V_3 . The condenser C_{16} also by-passes the R.F. components from the lower end of T_2 secondary to earth. The control grid of the pentode portion of V_2 is similarly biased by R_7 with C_9 by-passing the circuit. The control grid of V_1 is shunt fed, the resistance R_1 being the grid leak. As mentioned in para. 20, R_1 and the blocking condenser C_1 are contained in the chassis assembly and the tuned circuit in the transmitter unit.

Attenuation

39. As indicated in para. 27, the resistance R_{17} provides standing bias for the valve V_3 and a preset variable resistance, R_{18} , in series with R_{17} , is short-circuited at the remote controller when the key switch is in the R (Receive) position. When the switch is moved to the central position RA, the resistance R_{18} is connected in series with R_{17} thereby reducing the V_3 stage gain by an amount depending upon its setting. When the whole of the resistance of R_{18} is employed the reduction in gain is approximately 20 db. This reduces the background noise present in the absence of a signal, permitting clear I/C and a warning when a signal is received.

40. The connexions between the receiver and the chassis assembly are effected by means of an aerial plug Ae and a Jones plug RJP consisting of ten points which are—RJP₃, L.T. negative, H.T. negative and chassis earth; RJP₄, L.T. positive; RJP₅, A.G.C. line to R.F. that is to A1 contact of the transmit-receive relay REL $\frac{A}{2}$ (para. 48); RJP₆, receiver H.T. positive; RJP₇, microphone; RJP₈, receiver attenuation; RJP₉, microphone; RJP₁₀, low impedance output; RJP₁₁, I/C H.T. positive and RJP₁₂, high impedance output.

The chassis assembly, types 7 and 8, with controller, electric, type 4

41. The electrical system associated with the selector switch system for the TR.1196 is contained in the chassis assembly, type 7, designed for 24-volt operation. A similar chassis assembly, the type 8, is used with the T.R.1196A for 12-volt operation. The controller, electric, type 4, is exterior to this assembly. A theoretical circuit diagram of the two assemblies is shown in fig. 5. The circuit of the controller is incorporated on this diagram.

42. A maximum of four frequency channels, within the specified limits of from 4.3 Mc/s to 6.7 Mc/s are selected by the controller button-operated switches BS_a , BS_b , BS_c and BS_d , associated with the frequency channels A, B, C and D. A fifth button switch BS_o causes a starting relay $REL \frac{B}{1}$ to break the connexion to the power unit in the positive line. A three-position key switch S_3 gives positions for transmit (T), receive (R) and receiver attenuation (RA).

43. When any one of the buttons is pressed and one of the switches BS_a , BS_b , BS_c or BS_d made, a circuit is closed at the switch contacts whilst the OFF switch BS_o is mechanically rejected. The relay $REL \frac{B}{1}$ is energized. The power lines from the aircraft electrical supply, *via* a plug P_3 , are completed through the contacts Bl of $REL \frac{B}{1}$ to the power unit Jones type socket points $PJSk_9$ and $PJSk_{10}$ and the rotary transformer is started.

44. A secondary result of pressing one of four buttons and so closing the OFF contacts of BS_o is to make the circuit, which includes a motor Mo_1 , to which is ganged the frequency channel selector switch mechanism. This circuit includes the off-normal contacts F, the motor selector switch S_4 with a ganged cam S_{4a} , the make-and-break contacts Cl of the selector motor and the driving magnet $REL \frac{C}{1}$. A filter circuit consisting of a resistance R_2 and a condenser C_2 bridges the contacts Cl .

45. Reference to fig. 5 will show that at any one time, three sets of contacts are made to the motor selector switch S_4 . If one of these corresponds to the button depressed in the controller the power supply to the driving magnet $REL \frac{C}{1}$ is made and the motor Mo_1 is caused to turn.

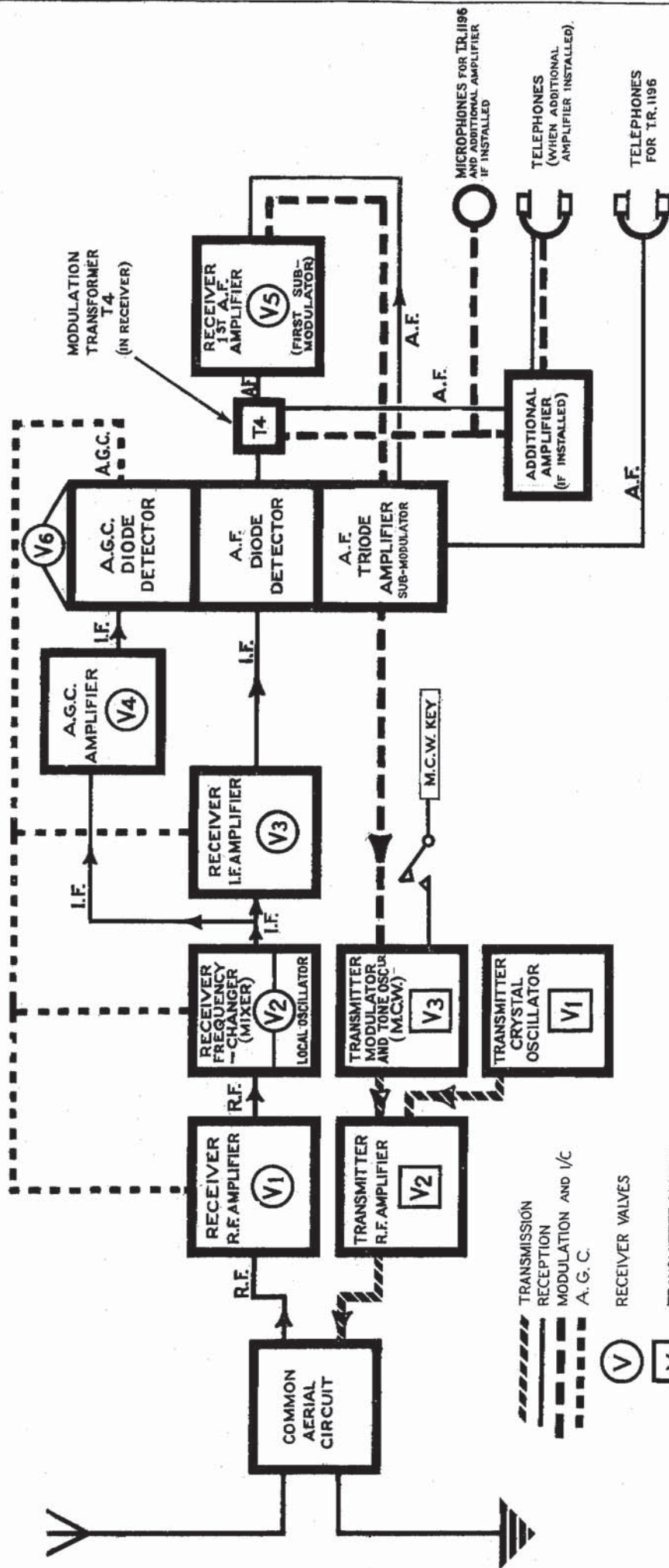
46. The electrical circuit is broken, momentarily, every 90 degrees of angular turn, by the opening of the contacts F by the cam S_{4a} . The motor Mo_1 , will, however, continue to turn until the selector switch S_4 arrives at a position at which the contact wired to the depressed button switch is open-circuited at the same time as the contacts F open. When this happens the motor stops and the circuit is completed to an indicator lamp PL_a , PL_b , PL_c or PL_d corresponding to the selected frequency channel A, B, C or D.

47. Pressing a further button will release the button already down and will provide an alternative circuit for the supply to the coil of the driving magnet $REL \frac{C}{1}$. This causes the motor again to turn until the selector switch S_4 arrives at the new position determined by the button used. Spring-loaded dog-clutches turn the selector switches of the transmitter and receiver to the positions necessary to bring the frequency channel A, B, C or D components and crystals into circuit. Bridging tags SA , SB , SC , SD provide for links which may be removed should less than four channels be required for operational reasons. This obviates the selection of non-set-up channels should the buttons associated with them be accidentally pressed. In this event the selector motor will not follow the normal sequence of operation but will remain at its original position, that is, on the set-up channel for which the button was previously pressed.

48. A transmit-receive relay $REL \frac{A}{2}$ has one set of standard contacts, $A2$, for H.T. positive switching and a separate set, $A1$, for disconnecting the A.G.C. circuit, to the receiver valve V_1 , when transmitting. The H.T. switching contacts are arranged to complete the H.T. supply circuit to the transmitter, the line being formed from the power unit *via* the power unit Jones socket point $TJSk_6$, when the coil of $REL \frac{A}{2}$ is energized. This occurs when the relay power circuit is completed at the controller key switch S_3 position T. At the same time the H.T. supply, *via* $PJSk_7$, contacts $A2$ and $RJSk_6$, to the R.F. portion of the receiver is disconnected. The switch position T also brings into circuit a pilot lamp PL_t .

49. Moving the key switch S_3 to the R or RA positions reconnects the H.T. supply to the receiver and disconnects the transmitter by the operation of contacts at RA position; the equipment is left in the receive (R) state but intercommunication is facilitated by a reduction of background noise in the absence of a carrier (*see* para. 39). High or low impedance telephones can be used, provision being made for a connecting link on a three-spill tag board. A two-point plug P_5 , on the controller, type 4, is fitted with a socket to which a push-button may be connected by suitable cable for remote control of TRANSMIT-RECEIVE switching.

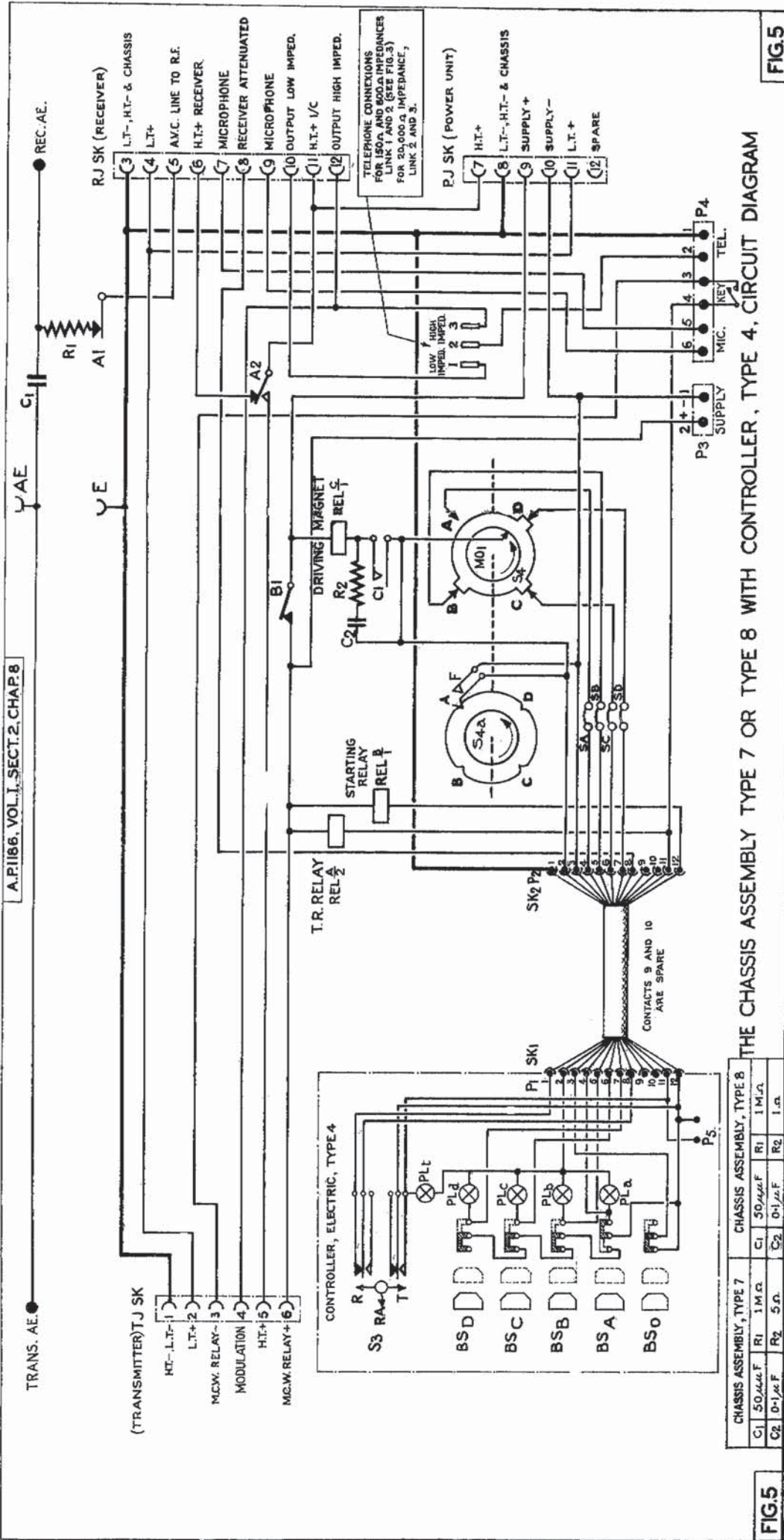
50. Connexions to the chassis assembly are made by a two-point W-plug P_3 for the aircraft electrical supply, a six-point W-plug P_4 for the microphones, telephones and MCW key and a 12-point



T.R.1196, BLOCK SCHEMATIC DIAGRAM

FIG. 4

FIG. 4



THE CHASSIS ASSEMBLY TYPE 7 OR TYPE 8 WITH CONTROLLER, TYPE 4, CIRCUIT DIAGRAM

FIG. 5

FIG. 5

CHASSIS ASSEMBLY, TYPE 7		CHASSIS ASSEMBLY, TYPE 8	
C1	50 μF	R1	1 MΩ
C2	0.1 μF	R2	5 Ω
		R3	1 MΩ
		R4	1 MΩ

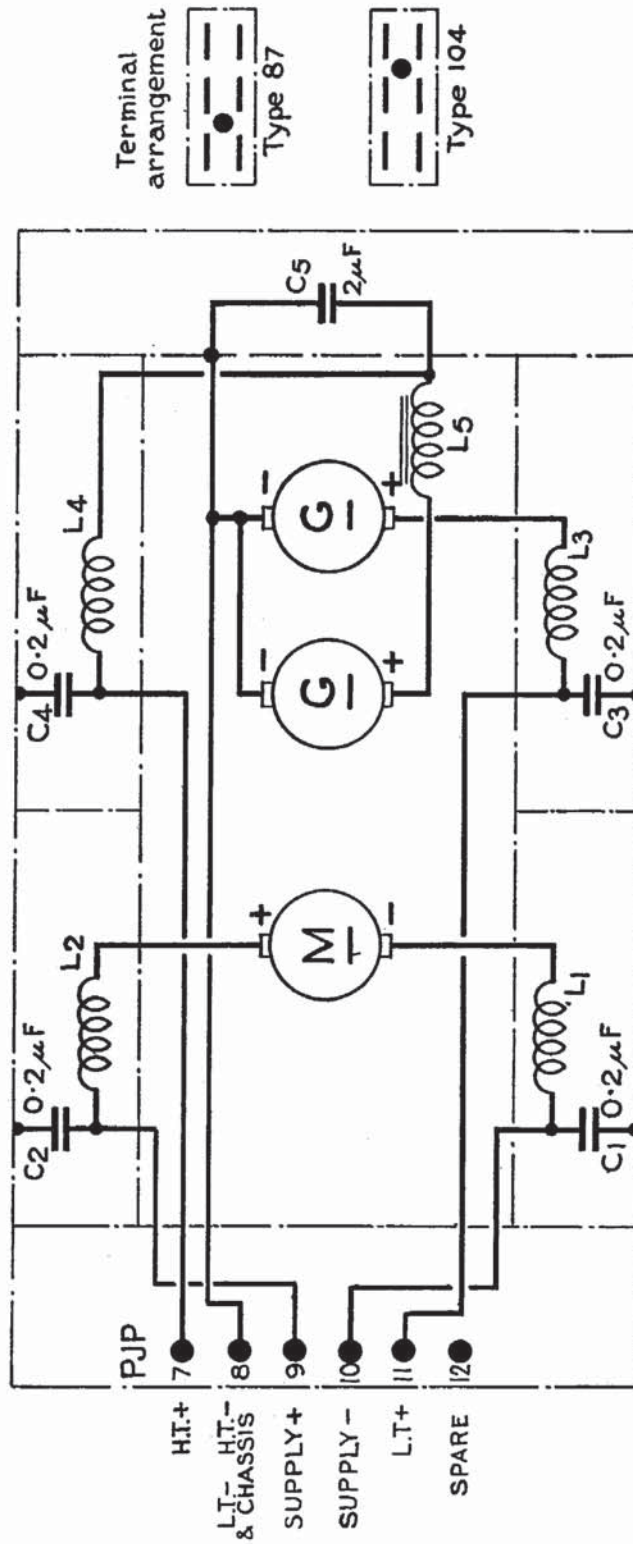


FIG. 6

THE POWER UNIT TYPE 87, OR TYPE 104, CIRCUIT

FIG. 6

W-plug P₂ for the controller, type 4. The transmitter connector is a six-point Jones socket TJSk having the following sockets:—TJSk₁, H.T. and L.T. negative and earth; TJSk₂, L.T. positive; TJSk₃, M.C.W. relay negative; TJSk₄ modulation; TJSk₅, H.T. positive and TJSk₆ M.C.W. relay positive.

51. Connection to the receiver is made *via* a ten-point Jones socket RJSk with the points:—RJSk₃, L.T. and H.T. negative and chassis earth; RJSk₄, L.T. positive; RJSk₅, A.G.C. line to R.F.; RJSk₆, H.T. positive; RJSk₇ microphone; RJSk₈, receiver attenuation, RJSk₉, microphone; RJSk₁₀, low-impedance output; RJSk₁₁, H.T. positive and I/C; RJSk₁₂, high impedance output.

52. The connexions to the power unit are made *via* the six-point Jones socket PJSk mating with the power unit Jones plug PJP. The points are:—PJSk₇, H.T. positive; PJSk₈, L.T. and H.T. negative and chassis earth; PJSk₉, supply positive; PJSk₁₀, supply negative and PJSk₁₁, L.T. positive, with PJSk₁₂ spare.

Power unit, types 87 and 104

53. The theoretical circuit diagram of the power units, type 87 and type 104, is shown in fig. 6. The unit consists of a three-commutator rotary transformer with its associated smoothing systems. The power unit is connected to the chassis assembly by a 6-point Jones plug PJP—The two units differ in respect of the rotary transformer windings but are identical in suppressor and filter components. They are continuously rated to give 30mA (receiver) with intermittent rating up to 65mA (transmitter). The rotary transformer has a permanent magnet field system.

54. The aircraft general electrical supply is fed to the power unit through the plug contacts PJP₉, positive, and PJP₁₀, negative. A R.F. choke is incorporated in each circuit with a condenser by-passing the circuit to earth. These chokes and condensers comprise screened suppressor unit combinations which are L₂ and C₂ and L₁ and C₁. Similar units L₃ and C₃ are in the L.T. output positive circuit and form part of the H.T. positive system (L₄ and C₄). A simple parallel rejector circuit consists of a choke L₅ and a condenser C₅ in the H.T. system. The output contacts are — PJP₁₁, L.T. positive; PJP₈, L.T. and H.T. negative and PJP₇, H.T. positive with PJP₁₂ spare.

CONSTRUCTIONAL DETAILS

55. A general arrangement view of the T.R.1196, showing the controller, type 4, and cables to the transmitter-receiver is shown in fig. 1, and a plan view of the instrument, with covers removed, is shown in fig. 7. Two views of the chassis assembly are shown in fig. 8 and fig. 9. The transmitter unit, type 22, is shown, with covers removed, in fig. 10, whilst fig. 11 is a view of the chassis underside. For clarity of illustration the screened tuning unit has been removed from the chassis in the view of the receiving unit, type 25, which is shown in fig. 12, the chassis underside being depicted in fig. 13 and fig. 14. The construction of the I.F. transformers is shown in the view of fig. 15. The chassis underside of the power unit is shown in fig. 16, a plan view of the instrument, with cover removed, forming part of fig. 7. The power unit base contains all components other than the rotary transformer.

56. The three units can be easily withdrawn from the main chassis assembly by means of handles which are secured, when the instrument is assembled, by captive knurled headed screws (1, fig. 1). The handle (19) of the transmitter unit is visible in fig. 1. Each unit is separately screened by mild steel boxes, or covers, cadmium or zinc plated internally and stove enamelled black externally. The position of the units is indicated on fig. 1 as (2) for the transmitter, (3) for the receiver and (4) for the power unit.

57. Connexions to the transmitter-receiver are made by cable connectors through W-type plugs and sockets. The top plug (5) is a two-point connexion from the aircraft general electrical supply accumulators, the centre six-way plug (6) accommodates the microphone, telephone and M.C.W. key leads from a junction box and the bottom, 12-way plug (7) is joined to the controller, type 4 (8). In this illustration the controller is shown with the anti-glare mask fitted over the pilot lamps for night operation. The blue shield is brought into operation by a switch (20).

58. On the upper surface of the instrument, as shown in fig. 1, can be seen the cover (9) through which the transmitter crystal units are inserted and the resonance indicating lamp PL₁ with its associated switch button (10). The captive knurled headed screws (11) secure the transmitter cover and the locks (12) serve to fix the aerial circuit trimmer tuning controls in position when set up on the "spot" frequencies.

59. The cover (13) is used to insert the receiver local oscillator crystal units, which are plus or minus 460 kc/s off the frequency of the transmitter crystals to which the transmitter-receiver is set up. The cover release screws of the receiver are indicated at (14) and the screwdriver adjusting and locking mechanism associated with the receiver R.F. transformer T₁ secondary are shown at (15). The four top plate release screws for the chassis assembly are indicated at (16). This plate carries the engraved label of instructions for setting up the equipment.

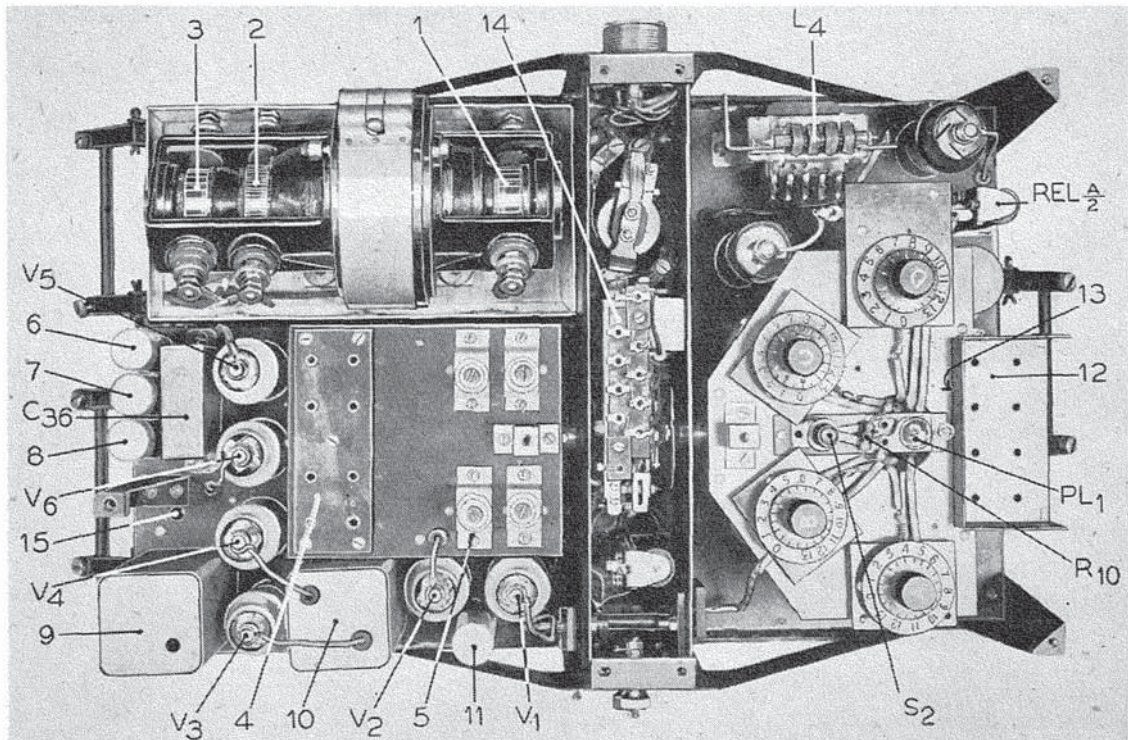


FIG. 7.—PLAN VIEW OF T.R.1196 WITH COVERS REMOVED

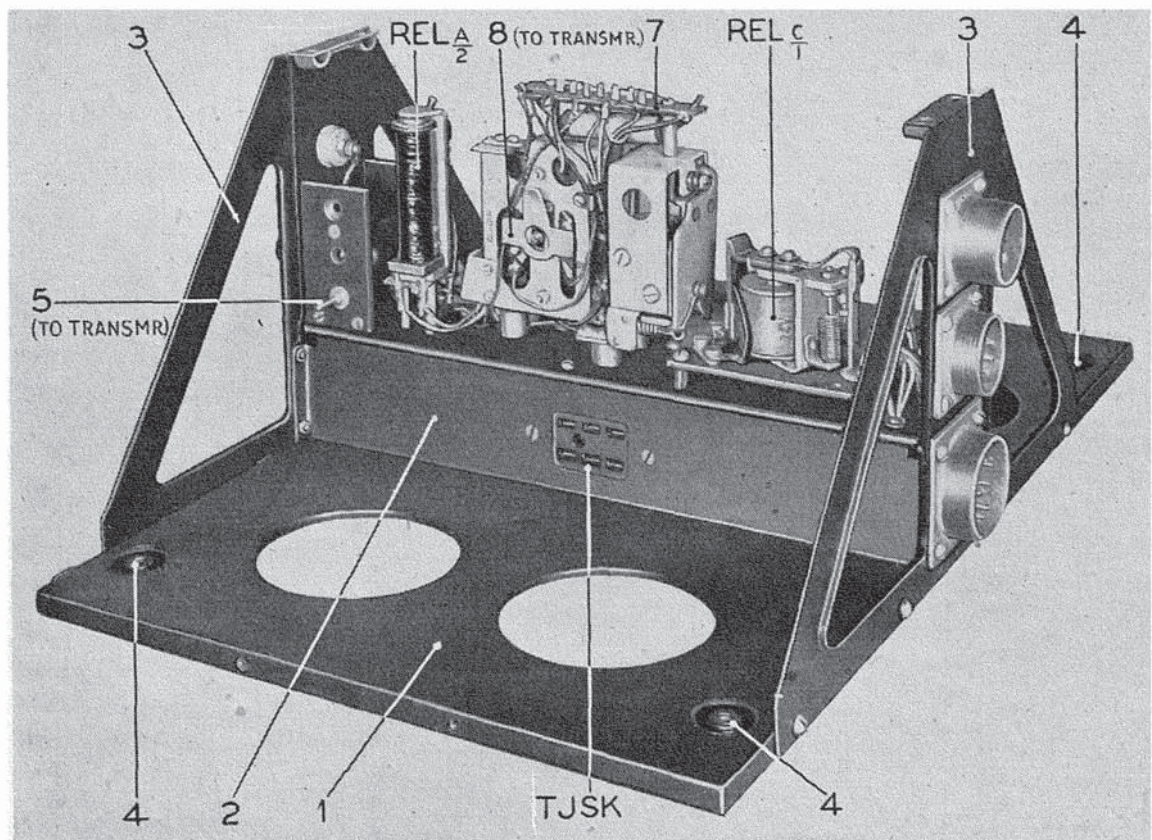


FIG 8.—CHASSIS ASSEMBLY, FROM LEFT-HAND SIDE

60. The plan view of fig. 7 shows the units in position. The three commutators or the rotary transformer are:—input (1), H.T. (2) and L.T. (3). The receiver crystal sockets are on a small panel (4) and adjacent to this is the platform (5) carrying the four screwdriver adjustments for the receiver condensers C_4 , C_5 , C_6 and C_8 . The three cans (6), (7) and (8) in the receiving unit each contain three condensers of the value of $0.1\mu\text{F}$. The can (6) contains C_{30} , C_{31} and C_{33} , (7) contains C_{20} , C_{24} and C_{27} whilst (8) has C_{17} , C_{19} and C_{23} . The first I.F. transformer T_2 can is (9) and the second I.F. transformer T_3 can is (10). The condenser can (11) of the receiving unit accommodates C_{12} , C_{14} and C_{16} .

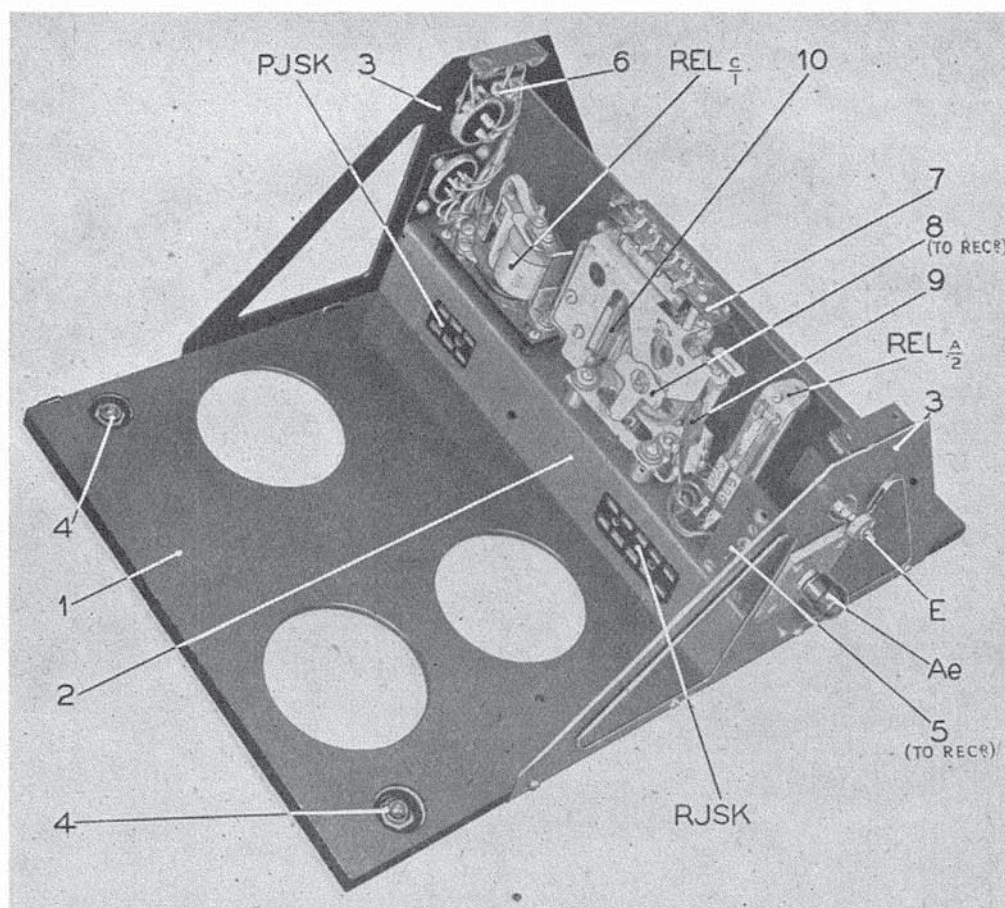


FIG. 9.—CHASSIS ASSEMBLY, FROM RIGHT-HAND SIDE

61. The bracket (12) containing the sockets for the transmitter crystals is sign-written with the ranges A, B, C and D on the return edge (13) and against each pair of sockets. The aerial circuit tuning coils each have two scale discs the outer of which is engraved 0 to 13 and the inner, or vernier, 0 to 10. The switch button of S_2 is engraved "PRESS TO TUNE".

62. The construction of the chassis assembly, type 7 or type 8, can be seen in the view presented in fig. 8 and fig. 9. The chassis assembly is constructed of 20 s.w.g. sheet steel and consists of a shallow inverted dish (1) construction forming a base plate, and has a raised transverse channel section (2) carrying all the plugs and sockets required for connexions between units and to apparatus external to the transmitter-receiver. The side members are strengthened by triangulated webs (3). On these side members are mounted the W-type sockets seen in fig. 8 and the aerial and earth terminal, seen in fig. 9.

63. Four $\frac{1}{4}$ in. B.S.F. threaded bushes (4) are mounted on lugs underneath the base for fixing the equipment in aircraft. A detachable cover plate, secured by 6 B.A. screws, may be removed to enable inspection of the Jones sockets and wiring underneath the transverse centre section. The annotations of fig. 8 and fig. 9 are similar. The floating location pins (5) engage with sockets on the transmitter (1, fig. 10) and receiver (1, fig. 12). The tag board (6) for high and low impedance telephones is shown in fig. 9. The links are engraved and, when issued, are arranged for high impedance telephones.

64. Four pairs of soldering tags coded SA, SB, SC and SD are mounted on an insulated panel (7). These are bridged when the equipment is set up for four channel operation. Should less than four channels be required it is only necessary to remove the appropriate link, or links, to prevent the selector motor operating due to the accidental pressing of an unused channel button in the controller, type 4.

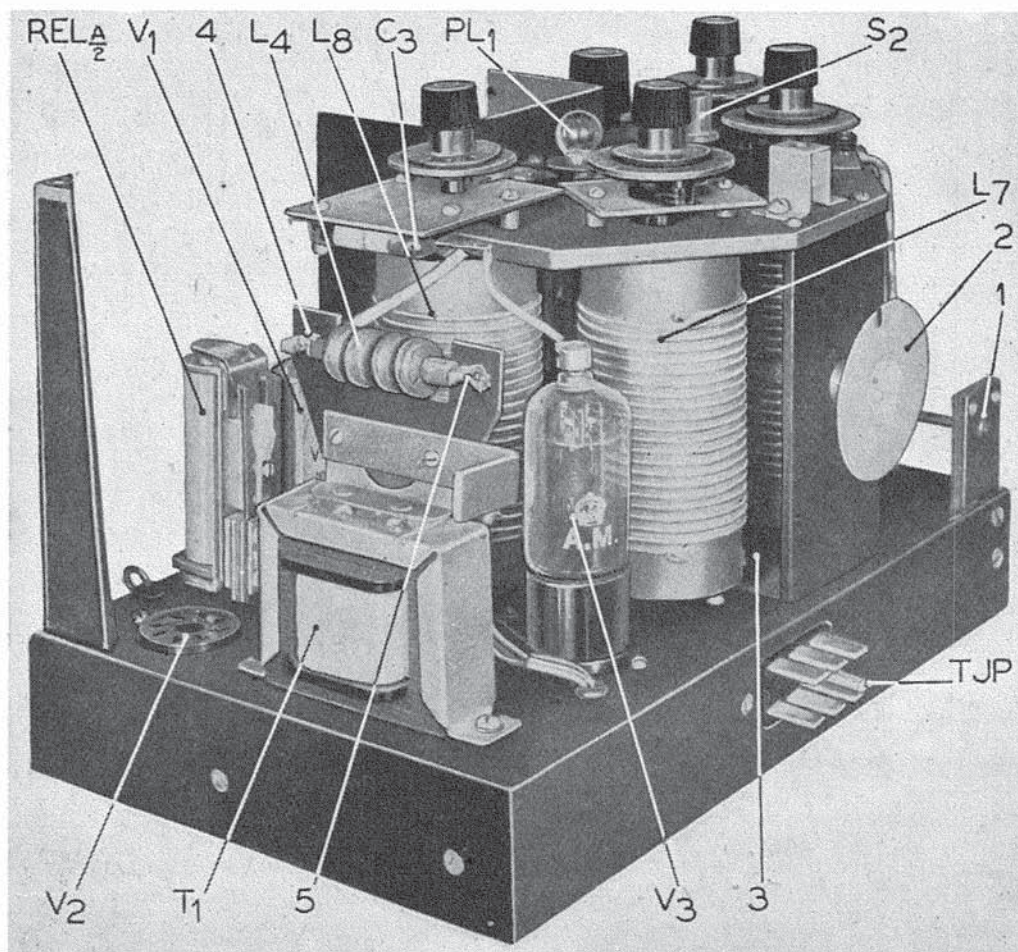


FIG. 10.—TRANSMITTER UNIT, WITH COVER REMOVED

65. Spring-loaded dog clutches (8) actuated by the selector motor MO_1 turn the selector switches of the transmitter and receiver to the position necessary to bring into circuit the components and crystals associated with the tuning channels. The T/R relay $REL \frac{A}{2}$ has one set of contacts for H.T. positive switching and a separate set for aerial changeover. The OFF-NORMAL contacts (9) are shown in fig. 9.

66. In the illustration of the transmitter unit, fig. 10, can be seen the slotted circular metal disc (2) which projects from the inner side of the unit and engages with the dog clutch (8, fig. 8). The selector motor shaft is double ended and drives a similar disc (2, fig. 12) on the receiving unit. The valve V_2 has been removed, in this illustration, to afford a better view of the M.C.W. relay $REL \frac{A}{2}$. The transmitter coils L_5 , L_6 , L_7 and L_8 are space wound on cylindrical formers with closed ends through which are secured, by set screws, bakelized fabric spindles. Bearings for the spindles lead off the end connexions of the coils and enable them to be rotated by turning the engraved knobs.

67. The tapping adjustment of the coils L_5 , L_6 , L_7 and L_8 is obtained, through rotation, by means of a small grooved wheel connector, free to move in a vertical plane along a circular guide rod mounted parallel to the coil and held in position at each end by small helical rings (1, fig. 11).

In this manner suitable aerial matching to the output circuit is arranged. As practically the whole of the shunt capacitance to this circuit is represented by the aerial, an efficient transfer of power from the anode of the transmitter output valve V_2 is effected.

68. The base fixing lugs (2) of the transmitter underside are indicated in fig. 11, in which illustration can be seen the accessible manner in which components are mounted to facilitate checking and replacement. From the receiver chassis view, fig. 12, the R.F. amplifier and tuning unit has been removed and is shown (as an interior view) at the side of the main chassis. The operation of removal is effected by the withdrawal of four screws (3) and by unsoldering four connectors (4) which lead through the rubber grommets (5) on the main chassis. The underside of the crystal sockets (6) is shown. The remaining annotations of main components can be found in fig. 7.

69. Two views of the under-chassis arrangement of the receiver are shown in fig. 13 and fig. 14. The adjustment port (1) for R_{23} is indicated in the former. The construction of the two I.F. transformers T_2 , T_3 is illustrated in fig. 15. The anode connector (1) leads to the top cap of the frequency-changer V_2 whilst the connector (2) joins to the grid top cap of the I.F. amplifier V_3 . The under-chassis view of the power unit is shown in fig. 16; a typical suppressor unit (1) has been included, the R.F. choke (2) and paralleled condensers (3) being indicated. The corresponding suppressors shown in the chassis are:—input negative (4), input positive (5), L.T. positive (6) and H.T. positive (7).

VALVES AND POWER SUPPLIES

70. The following valves are used in the transmitter-receivers T.R.1196 and T.R.1196A:—

Transmitter unit, type 22

V_1 crystal oscillator 9-pin glass base pentode valve, V.R.91 (Stores Ref. 10E/92)

V_2 output octal base tetrode valve, V.T.501 (Stores Ref. 10E/389)

V_3 modulator and octal base pentode valve, V.T.52 (Stores Ref. 10E/11398).

Receiving unit, type 25

V_1 and V_3 variable- μ pentode valves, R.F. amplifier and I.F. amplifier, V.R.53 (Stores Ref. 10E/11399).

V_2 octode frequency changer valve V.R.57 (Stores Ref. 10E/11403)

V_4 pentode A.G.C. amplifier valve V.R.56 (Stores Ref. 10E/11402)

V_5 pentode 1st A.F. and microphone amplifier valve V.R.56 (Stores Ref. 10E/11402)

V_6 double-diode-triode output and 2nd microphone amplifier valve V.R.55 (Stores Ref. 10E/11401).

All the receiver valves are fitted with international octal bases.

71. The power supplies are derived from the aircraft general electrical system accumulators through either the power unit, type 87 (nominal 24 volts) for the T.R.1196A or the power unit, type 104 (nominal 12 volts) for the T.R.1196. The H.T. consumption of the transmitter is 60 mA at 250 volts and the heater consumption is 1.3 amp. at 6.3 volts. The total H.T. consumption of the receiver, at full gain, does not exceed 35 mA at 250–275 volts whilst the heater consumption is 1.2 amp. at 6.3 volts. The H.T. consumption of the microphone amplifier alone is 10 mA. The power input is approximately 5 amps. at 13 volts or 2.5 amps. at 26 volts for the 12-volt and 24-volt installations respectively.

INSTALLATION

72. A typical installation diagram is shown in fig. 17. Depending upon the type of aircraft involved, the transmitter-receiver may be fitted to a vertical bulkhead as an alternative to the normal horizontal position. In either eventuality it is secured by four $\frac{1}{4}$ in. B.S.F. bolts, and fixing centres are 14 in. by 9.5 in. The threaded $\frac{1}{4}$ in. bushes can be seen, annotated (4), in figs. 8 and 9.

73. The position chosen for fixing should ensure that the minimum length of lead-in wire to the aerial terminal is necessary. A good earth connexion bonded to the aircraft frame is essential. The multi-way cables connecting the aircraft general electrical supply, the microphones, telephones and remote controller will depend upon the aircraft installation and the position in which the equipment is installed. It is important, however, that sufficient clearance above the controls, tuning indicator and crystal covers should be allowed to permit adjustment when needed. A minimum of three inches clearance should be left, at either end, to enable the individual units to be removed, when necessary, by means of the hinged handles. Similarly, sufficient hand-room clearance must be allowed at the side for connecting the W-type sockets to their plugs on the chassis assembly.

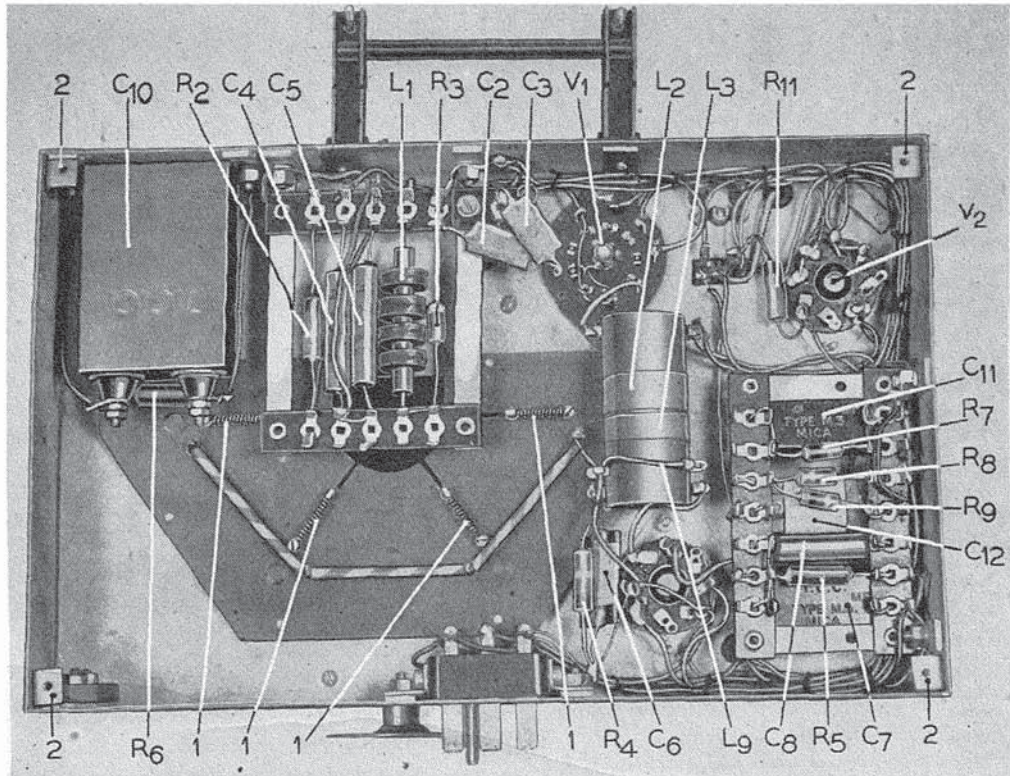


FIG. 11.—TRANSMITTER UNIT, UNDERSIDE OF CHASSIS

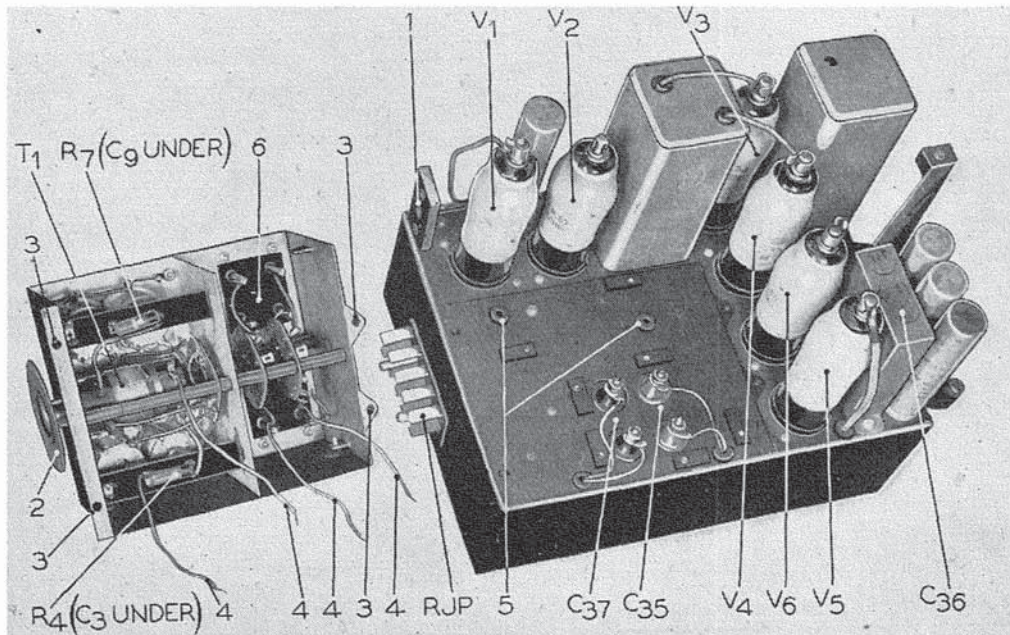


FIG. 12.—RECEIVING UNIT, AND INTERIOR OF TUNING UNIT

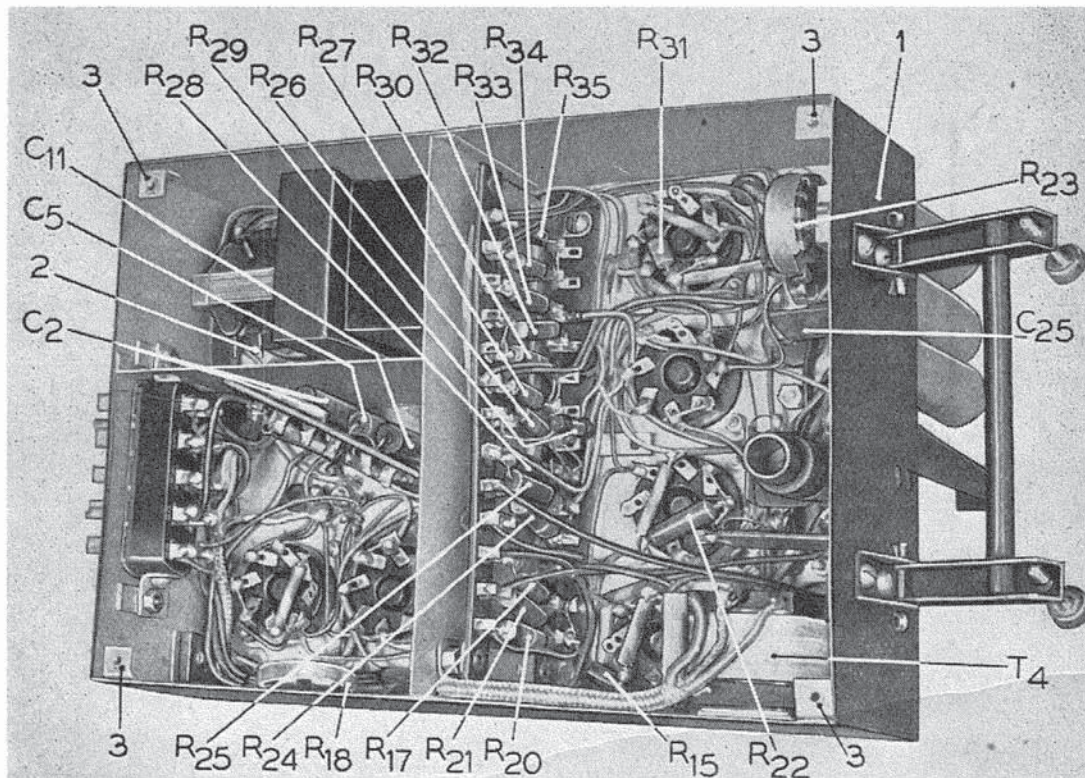


FIG. 13.—RECEIVING UNIT, UNDERSIDE OF CHASSIS

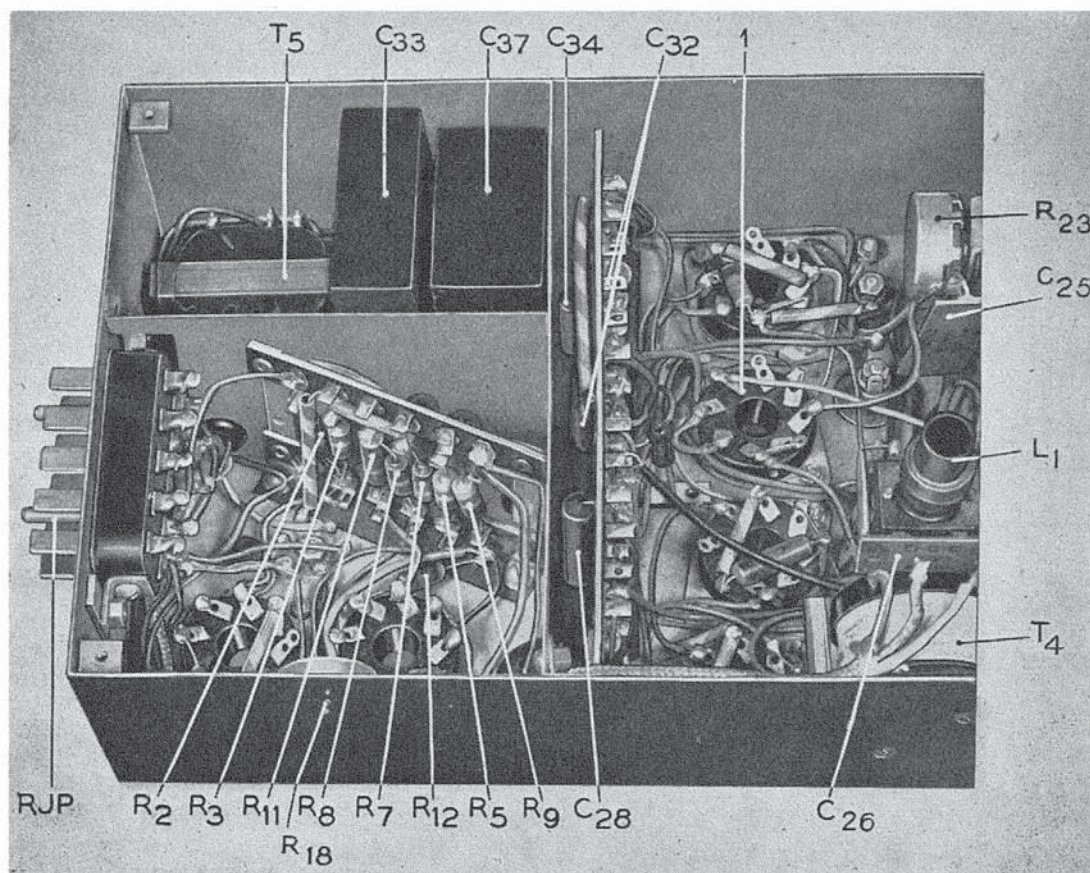


FIG. 14.—RECEIVING UNIT, UNDERSIDE OF CHASSIS FROM LEFT-HAND SIDE

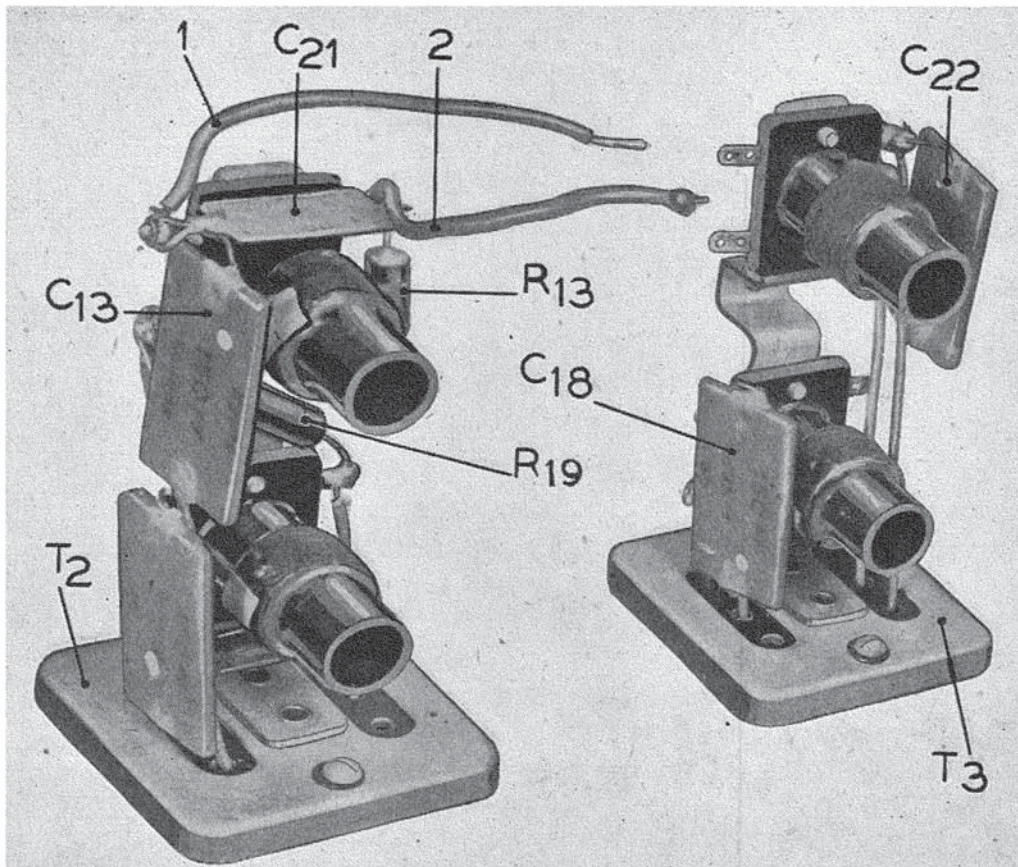


FIG. 15.—I.F. TRANSFORMERS WITH CANS REMOVED

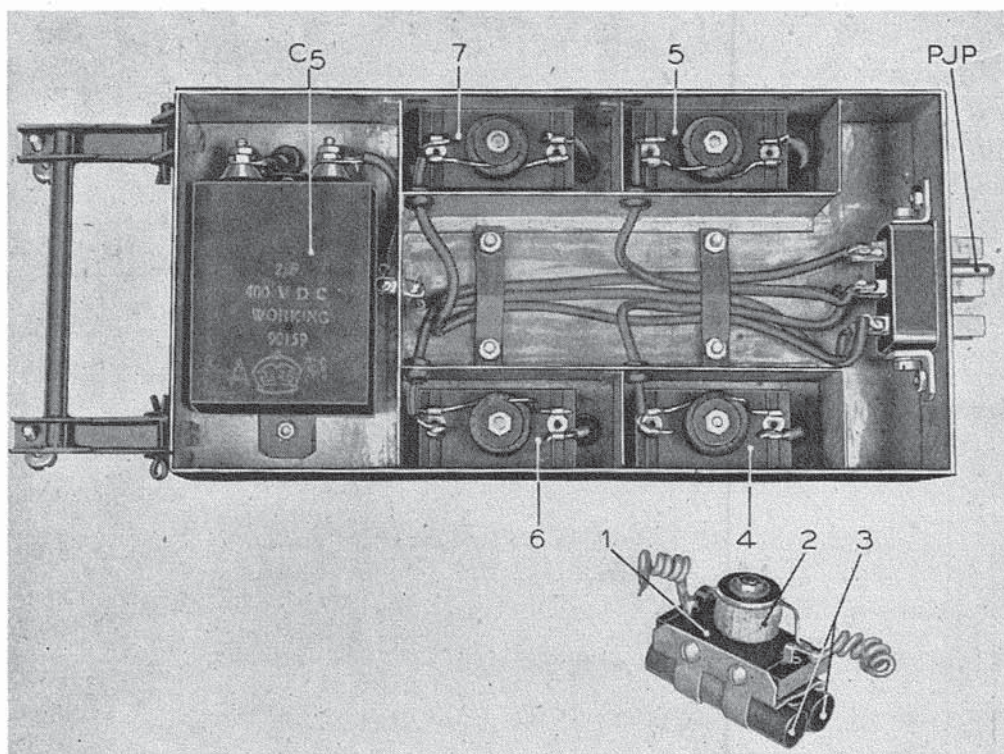
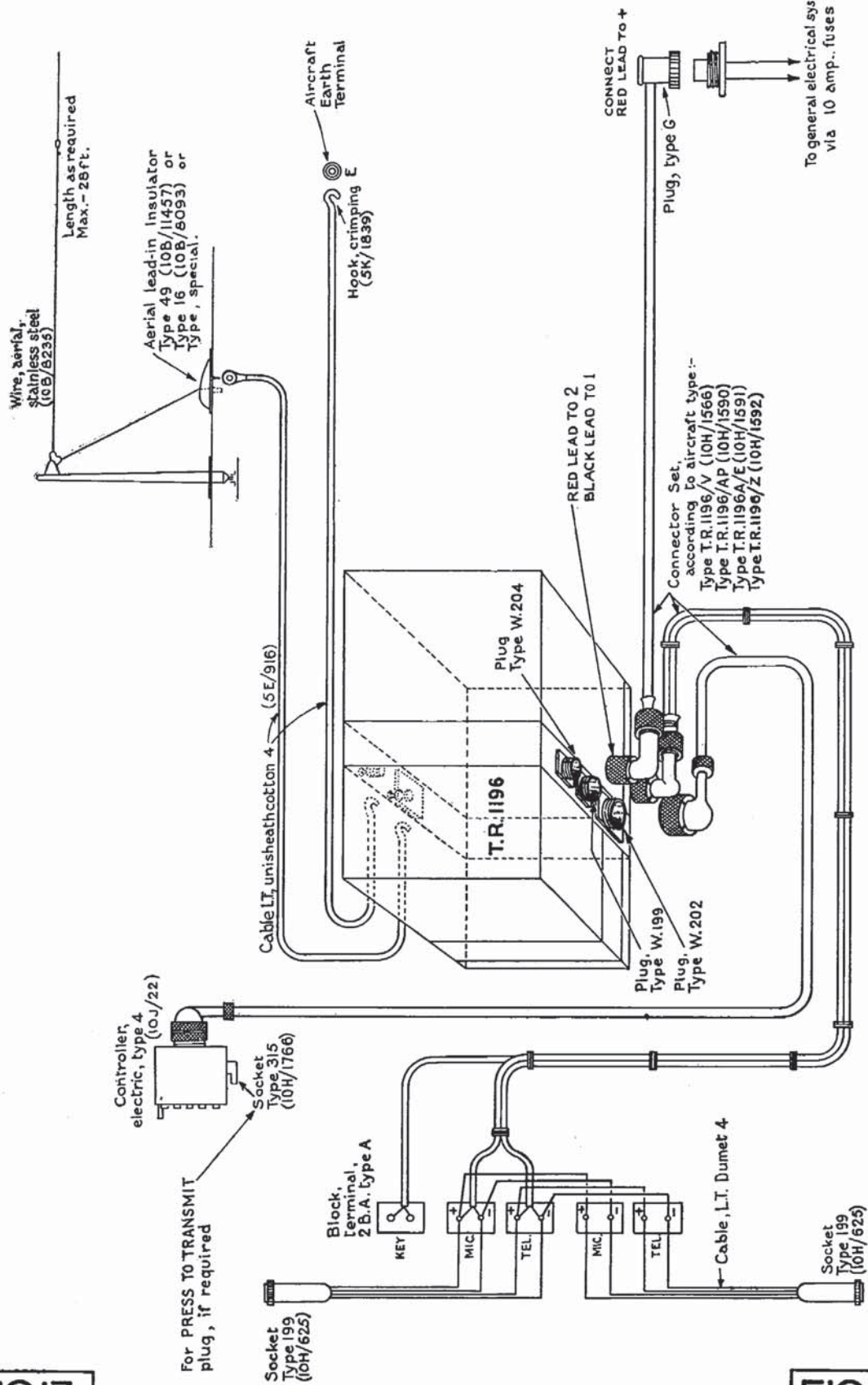


FIG. 16.—POWER UNIT, UNDERSIDE OF CHASSIS



TYPICAL INSTALLATION DIAGRAM

74. Two points may be mentioned here relative to the responsibility of installation. Firstly, as the instrument may be used with three types of telephones, that is with impedance of 150 ohms, 600 ohms and 20,000 ohms, the appropriate soldering operations should be carried out. A phone tag board engraved HIGH and LOW will be found in the chassis assembly (6, fig. 9). A short length of wire connects either of the end tags to that in the centre and connexion should be made according to the type of telephones to be used. Should 150-ohm impedance telephones be required a further soldering connexion should be made (retaining the LOW connexion on the tag board) to the receiver transformer T_5 . Referring to fig. 13, unsolder the connexion from the receiver Jones plug RJP_{10} at the transformer IS tag and reconnect to the spare tag (2). For this operation the base plate must be removed by means of the screws which fit into lugs (3). The circuit diagrams of fig. 5 and fig. 3 show, in insets, the tag board and transformer connexions for each type of telephone. The 150-ohm impedance telephones are the receiver telephones, head, type 32, and the 20,000-ohm may be type 16 or 17 or type C. The 600-ohm types are, at the time of writing, not included in the vocabulary, A.P.1086.

75. Secondly, the channels to be used for transmission are governed by soldered tag connexions on the small panel (7, figs. 8 and 9, or 14, fig. 7) in the chassis assembly. These are engraved SA, SB, SC and SD and the tags corresponding to the channels not required should be removed.

76. In installations requiring I/C service to more than three positions it is necessary to instal an amplifier A.1134 or other suitable instrument. Should this eventuality arise instructions for installation will be promulgated.

OPERATION

77. Study of these operational notes will be assisted by reference to the illustrations specified. As the equipment is used on "spot" frequencies no actual adjustment of a tuning nature other than operation of the button switches is undertaken in flight. The transmitter-receiver is preset on the ground.

78. The transmitter-receivers are supplied with all valves inserted and the first operation should be to ensure that all top cap leads are securely contacting. Referring to fig. 1, the steps to be taken to dismantle the apparatus for valve substitution, inspection or servicing are as follows. Remove the transmitter unit (2) from the main chassis by means of the handle (19) which is secured by captive knurled headed screws (1). A firm equalized pull will withdraw the transmitter from the chassis assembly Jones socket and floating "aerial" pin. Three captive screws (11) secure the transmitter cover. Release these and open the four locking devices (12) which hold the trimmer control knobs A, B, C and D. The cover may now be withdrawn. If valve substitution is necessary, insert the valves, connect top caps and replace the cover, securing the screws. Re-insert the transmitter in its position in the main chassis using the guiding lugs as an indication. Push well home and secure the captive screws of the handle.

79. The receiving unit (3) is similarly equipped with a withdrawal handle. Treatment of this unit depends upon the type of telephones and the frequency channels to be used. Whilst this may be regarded as an installation responsibility a check-up on the telephone and channel connexions as specified in paras. 74 and 75 should be made before replacing the unit. The receiver attenuation resistance R_{18} (see fig. 13) should be preset prior to installation, according to the operational circumstances in which the transmitter-receiver is desired to be used (see para. 87).

80. The W-type socket-ended connectors should now be attached to the plugs as shown in fig. 1, and the sleeving screwed tight. The top connector (5) leads to the aircraft electrical system, the centre connector (6) to the junction box from which connexion is made to the M.C.W. key and to the external amplifier if used. The bottom connector (7) leads to a W-type plug on the controller unit (8). The aerial and earth terminals can be seen in fig. 9. The earth lead is attached to an aircraft earth terminal suitably positioned and bonded to the airframe structure.

To set up the transmitter

81. The crystals appropriate to the channel frequencies to be operated are inserted *via* the door (9, fig. 1) on top of the transmitter. The transmitter functions on crystal fundamental frequency and the crystals are to be selected according to the stores reference number which represents the frequency, expressed in kilocycles, to which the quartz plate is ground. For instance, should the desired operational frequency be 5 Mc/s, the stores reference of an appropriate crystal would be 10K/5000. Should less than four channels be needed for operation a note should be made of the channel reference letters used. The crystal cover should be securely fastened by the captive screw (17).

82. The output circuit corresponding to the desired frequency channels should now be adjusted. Move the switch S_3 in the controller, to position T (TRANSMIT) and select the frequency channel to be set up by pressing the appropriate button switch BS_a , BS_b , BS_c or BS_d . This operation rejects the OFF-normal button switch BS_0 . Next, press the PRESS-TO-TUNE button (10) retaining

pressure whilst adjusting the control knob A, B, C or D, corresponding to the channel being set up, until the resonance indicator lamp PL_1 attains maximum brilliance. With the switch S_3 in the T position the pilot lamp PL_1 in the controller will also glow.

83. Some indication of the direction in which the control has to be turned to arrive at the resonant position may be seen from the position of the counting device since frequencies near the higher limit (6.7 Mc/s) of the band will necessitate the coil tapping moving towards the maximum number, 13. The converse holds for crystals near the lower limit of the band, 4.3 Mc/s, when the tapping will approach 0. Final adjustment for lamp brilliance and resonance is made by the inner scale, engraved 0 to 10. A rough check may be made to ensure that the transmitter is modulated; whilst speaking into the microphone the brilliance of PL_1 should increase.

To set up the receiver

84. To set up the receiver insert crystals, *via* the door (13). These crystals should differ from the selected channel frequencies by plus or minus 460 kc/s. Refer to the note made of the channels selected (see para. 81) before inserting the holders into position. As an example, should the transmitter crystal frequency for channel A be 5 Mc/s, a crystal, the stores reference of which is 10X/4540 or 10X/5460, should be utilized for channel A of the receiver. The receiver crystal door is securely locked by a captive screw (18).

85. Set the controller key switch S_3 to position R (RECEIVE) then each channel selector button BS_a , BS_b , BS_c or BS_d should be pressed in turn and the corresponding preset condenser (15) engraved A, B, C or D, corresponding to C_4 , C_5 , C_6 and C_7 of fig. 4, should be separately adjusted. These condensers are of the screwdriver adjusted type and are equipped with knurled locking knobs. The adjustment should be made for maximum 'noise' output. In this way the receiver may be set up without the aid of measuring instruments.

86. It is now necessary to preset the built-in volume control R_{23} the screwdriver adjustment of which is situated on the withdrawal end of the receiver (1, fig. 13). In order to obtain the maximum benefit from the attenuating circuit of the I.F. amplifier V_3 (R_{18}) it is essential to avoid operating the L.F. amplifiers V_5 and V_6 at a higher level than is necessary thus avoiding limiting due to overloading. To ensure this, the following procedure should be followed. During ground testing, switch to the R (RECEIVE) position and, in collaboration with the ground station, ascertain the minimum setting of R_{23} at which adequate volume is obtained. Normally it will be found that adequate output is obtained when R_{23} is set at three-quarters of a turn in the clockwise direction. Its adjustment will not affect the gain of the microphone amplifier. No adjustment of the volume level is needed during operation since the A.G.C. system maintains the output voltage constant, within plus or minus 2 db, for a variation of from 10 microvolts to 100 millivolts.

87. After the equipment has been adjusted, as outlined in the foregoing paragraphs, the key in the controller, type 4, is moved to the central position (RA) and the preset resistance R_{18} control (see fig. 14) should be adjusted to a point at which background noise produced by the receiver will allow the I/C system to be used.

88. The A.F. amplifier output supplies side tone to points on the installation where telephones are connected. When it is desired to use M.C.W. a morse key is attached to the junction box to which tags 3 and 4 of the chassis assembly W-plug P_4 are connected and a tone-modulated (800 c/s to 1,500 c/s) carrier is used. Pressing the key actuates the M.C.W. relay $REL \frac{A}{2}$ in the transmitter when the key switch S_3 of the controller is in the T position. When it is desired to override the transmitter key a plunger-operated switch should be wired to the plug P_6 mounted at the end of the controller nearer to the OFF button. This gives a PRESS-TO-TRANSMIT condition.

89. Should I/C only be required the key switch S_3 is moved to the RA (RECEIVER ATTENUATION) position, that is, central, and one of the channel buttons should be pressed to reject the normal OFF button BS_0 . The apparatus takes approximately 30 seconds to reach an operating temperature.

PRECAUTIONS, MAINTENANCE AND REPLACEMENT PROCEDURE

90. The variable controls of the transmitter-receiver are reduced to a minimum and this obviates the necessity for continual check on the alignment of the units. Generally, adjustments will only be necessary when changing the frequency of any of the four channels. However, it may be advisable, occasionally, to check the settings of the transmitter output circuit coils by testing them to see whether alterations of the adjustment increases the brilliance of the indicator lamp PL_1 .

91. When set up the transmitter trimmers should be locked (12, fig. 1). The preset trimmers in the receiver should not need any readjustment provided they are initially correctly set up and securely locked (15, fig. 1).

92. In no circumstances should any attempt be made to dismantle the crystal unit should fracture be suspected and it is not intended that repairs to this unit should be carried out at stations. When fracture or other fault is suspected, replacement of the crystal unit must be made and the faulty unit returned through the usual channels in accordance with the routine procedure.

93. When either the transmitter unit or the receiving unit is removed or both units are removed, from the instrument for adjustment or repair, it is possible that the discs located on the ends of the selector switch shafts may be accidentally turned out of alignment with the dog clutch and, on re-assembling they may not engage. It is therefore necessary, after replacing, to turn the selector motor through 360 deg. by pressing the button switch preceding that corresponding to the original position. For instance, if the last button pressed, before dismantling, should be BS_a , it is now necessary to press BS_d . This will cause the motor to turn through 270 deg. Then press the next button in sequence (BS_a), which is the button corresponding to the original channel, and this brings about a further 90 deg. of angular turn.

94. In the event of the transmitter output coils being withdrawn this may be done by unscrewing two lug screws situated at the top and bottom of the coil former. One of these screws (the lower) may be seen on Coil C and is indicated (3) on fig. 10. It is very essential, however, that care should be taken in re-assembling the coil, and fig. 18 indicates the correct position for the connecting contact washer at the bottom of the coil assembly.

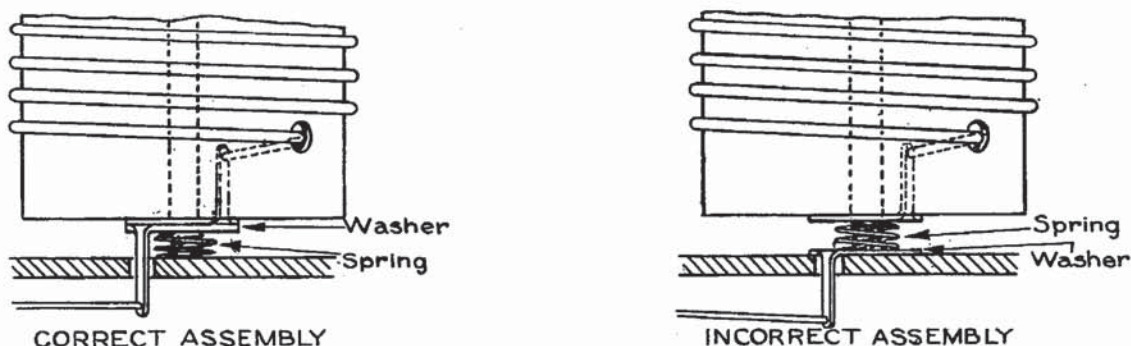


FIG. 18.—COIL ASSEMBLY DIAGRAM

95. Sluggish operation of the channel selecting motor will usually indicate that the OFF-NORMAL contact F (9, fig. 9) and/or the driving motor make-and-break contacts C1 (10, fig. 9) require cleaning. These contacts are both accessible when the transmitter and receiving units are removed from the chassis assembly. The tool to be used for contact cleaning is a contact cleaner, type 1 (Stores Ref. 1H/6) as this does not abrade the contact points.

96. In the event of complete failure of the transmitter-receiver a quick test of the H.T. voltage may be made by removing the top cover of the chassis assembly and measuring, with a suitable meter, the H.T. voltage at the standard set of contacts on $REI_{\frac{A}{2}}$, the T/R relay.

97. A useful aural indication of the effect of switching to TRANSMIT may be obtained by noting the change in note level made by the power unit generator. Should the note fall due to the transmitter load it is an indication that the H.T. feed to that unit is being made. This test eliminates the possibility of faults in switching-on of the inter-connexion between transmitter and power unit.

98. Valve substitution in both transmitter and receiving units is carried out after removing the top covers as indicated in the operation notes to this chapter. Care should be taken to switch OFF when the change is being made. Special precautions should be taken to ensure that the pins of the transmitter valve V_1 type V.R.91, are properly aligned before applying any pressure.

99. Only one test can be made for H.T. voltage on the transmitter unit with the top cover removed, and that is the anode and screen voltage to the valve V_3 , type V.T.501. This test can be taken at the end of the choke L_4 . The point is indicated as (4) on fig. 10. A test at the opposite end (5) will give the anode voltage only of V_3 .

100. Since all the top cap connexions of the valves in the receiving unit are control grids, no H.T. tests are possible without removing the chassis from the mounting unit and testing with an independent power supply. The normal methods of trouble location as indicated by instrument

performance will apply. A check of the A.F. portion will be possible using a microphone and telephones of known reliability. Assuming the A.F. tests indicate that this part of the receiver is in order, tests will have to be made for faults located in the R.F. or I.F. portions.

101. A suitable signal generator (see para. 103) and audio output meter are necessary to carry out realignment of the I.F. transformers and the A.G.C. amplifier anode circuit. This alignment can only be done with the chassis removed from the chassis assembly since the A.G.C. voltage to the controlled valves must be disconnected when realigning the I.F. transformers. This can more easily be done by disconnecting the second diode of the valve V_6 (1, fig. 14) as it is undesirable to remove the A.G.C. amplifier V_4 since its capacitance will have some effect upon the trimming of the secondary of the transformer T_2 . The alignment of the I.F. must only be attempted by properly authorized and equipped units.

102. After lining-up the I.F. transformer, the second diode of V_6 may be reconnected and with a signal of 1 millivolt at 450 kc/s applied to the control grid of V_2 , the iron dust core of L_1 should be adjusted (15, fig. 7) to give minimum dip as indicated on the output meter.

103. It is important to note that with the crystal control of both transmitter and receiver the centre of the I.F. pass-band must be located exactly on 460 kc/s and realignment should not be attempted unless a signal generator is available which has been checked against a frequency standard and is known to be accurate to plus or minus 0.5 kc/s at 460 kc/s.

104. As the rotary transformer of the power units has a permanent magnet field system no attempt should be made to remove the armature, as this would result in loss of magnetism. The rotary transformer should be replaced as a unit whenever failure occurs. The bearings are grease-packed and should require no attention. Although specifically intended for generators Section V, Chapter 1, of A.P.1095 applies equally to this apparatus.

105. The necessity for absolute cleanliness, particularly of the commutators and brush gear cannot be too often stressed. The use of abrasives for commutator cleaning is an extreme method, the use of rag, sparingly soaked in cleansing fluid, such as petrol, being the safer treatment.

106. The brushes are supplied with contact faces already shaped to the commutator. The following list gives the approximate brushes, with stores references, used with the different types of rotary transformer.

Power unit	Rotary Transformer				Brush (Stores Reference)	
					H.T.	L.T.
Type 87 ...	Type 52 (Stores Ref. 10K/568)	...	...	...	10K/570	10K/569
	Type 258 (Stores Ref. 10K/270)	...	...	...	10K/566	10K/565
Type 104 ...	Type 51 (Stores Ref. 10K/567)	...	...	...	10K/570	10K/569
	Type 257 (Stores Ref. 10K/269)	...	...	...	10K/566	10K/565

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for the transmitter-receivers the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in figure	Remarks
10D/325	Transmitter-receivers, T.R.1196 and T.R.1196A	1		
	Comprising:—			
10D/550	Chassis assembly, type 7	1		T.R.1196
10D/551	Chassis assembly, type 8	1		T.R.1196A
10K/201	Power unit, type 87	1		T.R.1196
10K/238	Power unit, type 104	1		T.R.1196A
10P/11	Receiving unit, type 25	1		T.R.1196 and T.R.1196A
10R/23	Transmitter unit, type 22	1		T.R.1196 and T.R.1196A
	Chassis assembly, type 7	1	Fig. 5	T.R.1196 (24-volt)
	Principal components—			
10H/1150	Aerial plug unit	1		
	Fitted with—			
10C/4323	Condenser, type 2229	1	C ₁	50 μ F
10C/11384	Resistance, type 480	1	R ₁	1 megohm
	Plug			
10H/392	Type W.199	1	P ₄	6-pole panel mounting
10H/395	Type W.202	1	P ₂	12-pole panel mounting
10H/397	Type W.204	1	P ₃	2-pole panel mounting
	Relay magnetic			
10F/719	Type 256	1	REL ₂ ^A	
10F/679	Type 246	1	REL ₁ ^B	Starting
10D/373	Selector-drive unit	1	MO ₁	24-v. step by step motor
	Fitted with—			
10C/10165	Condenser, type 386	1	C ₂	0.1 μ F
10D/501	Clutch	2		
10C/6455	Resistance, type 6455	1	R ₁	5 ohms
	Socket			
10H/11615	Type 69	1	RJSk	10-pole
10H/1450	Type 303	2	TJSk, PJSk	6-pole
	Terminal			
10H/7227	Type C	1	Ae	
5A/472	Instrument, single, 4 B.A.	1	E	
	Power unit, type 87		Fig. 6	T.R.1196
	Principal components—			
10K/637	Base	1		
10C/2098	Choke, type 60	1	L ₅	
	Condenser			
5C/1735	Type	8	C ₁ , C ₂ , C ₃ , C ₄	0.1 μ F (2 off each)
10C/4510	Type 2336	1	C ₅	2 μ F
10K/638	Cradle	1		
	Cover			
10K/641	Bottom	1		
10K/640	Top	1		
10H/1523	Plug, type 360	1	GJP	6-pole
10K/568	Transformer, rotary, type 52	1		
	or			
10K/270	Transformer rotary, type 258	1		
	Receiving unit, type 25	1	Fig. 3	T.R.1196 and T.R.1196A
	Principal components—			
10H/1151	Aerial socket unit	1		Single-pole
10A/12865	Cap. valve, type 12	6		
10C/3424	Choke. R.F., type 161	1	L ₁	I.F. 460 kc/s
	Condenser			
10C/9755	Type 332	5	C ₂ , C ₅ , C ₁₁ , C ₂₈ , C ₃₄	0.01 μ F
10C/288	Type 652			
	or	1	C ₃₇	2 μ F
10C/4568	Type 2378			
10C/961	Type 893			
	or	4	C ₁₂ , C ₁₄ , C ₁₆ , C ₁₇ , C ₁₉ , C ₂₂ , C ₂₀ , C ₂₄ , C ₂₇ , C ₃₀ , C ₃₁ , C ₃₃	0.1 μ F + 0.1 μ F + 0.1 μ F
10C/4571	Type 2381			
10C/4325	Type 2230	1	C ₃₂	0.0005 μ F

Ref. No.	Nomenclature	Qty	Ref. in. figure	Remarks
	T.R.1196 and T.R.1196A (contd.) Receiving unit, type 25 (contd.) Principal components (contd.)—			
10C/4326	Type 2231	1	C ₂₅	0.0002 μ F
10C/4327	Type 2232	1	C ₂₆	0.0002 μ F
10C/4329	Type 2234	1	C ₂₉	0.0001 μ F
10C/4330	Type 2235	1	C ₃₆	0.1 μ F
	or			
10C/4569	Type 2379			
10C/4331	Type 2236	1	C ₃₅	0.5 μ F
	or			
10C/4570	Type 2380			
10A/12870	Disc, coupling	1		
10H/493	Holder, valve, type 73	6		International octal
10H/308	Plug, type 185	1	RJP	10-pole
10C/1725	Potentiometer, type 1725	1	R ₂₃	0.5 megohm
	Resistance			
10C/9134	Type 231	1	R ₁₁	50,000 ohms
10C/11381	Type 477	1	R ₁₂	50,000 ohms
10C/11384	Type 480	3	R ₁₄ , R ₂₅ , R ₂₆	1 megohm
10C/11499	Type 487	2	R ₂ , R ₇	100,000 ohms
10C/11666	Type 499	2	R ₅ , R ₁₀	400 ohms
10C/11670	Type 504	1	R ₂₁	5,000 ohms
10C/11673	Type 507	2	R ₃ , R ₂₀	200,000 ohms
10C/11674	Type 508	1	R ₂₄	0.5 megohm
10C/11682	Type 516			5,000 ohms
10C/11688	Type 522	1	R ₂₇	60,000 ohms
10C/6	Type 540	1	R ₂₂	500 ohms
10C/818	Type 924	2	R ₈ , R ₉	100,000 ohms
10C/6226	Type 6226	3	R ₃₁ , R ₃₄ , R ₃₅	600 ohms
10C/6441	Type 6441	2	R ₂₈ , R ₃₃	1 megohm
10C/6662	Type 6662	1	R ₁₅	100,000 ohms
10C/6870	Type 6870	1	R ₃₂	0.5 megohm
10C/6871	Type 6871	1	R ₂₉	0.25 megohm
10C/6872	Type 6872	1	R ₁₇	200 ohms
10C/7313	Type 7313	1	R ₁₈	5,000 ohms var.
10D/382	Tuning unit, type 69	1		
	Fitted with—			
	Condensers			
10C/9755	Type 332	2	C ₃ , C ₉	0.01 μ F
10C/4321	Type 2226	4	C ₄ , C ₆ , C ₇ , C ₈	0.0001 μ F var.
	Resistance			
10C/1018	Type 1018	1	R ₇	100,000 ohms
10C/6662	Type 6662	1	R ₄	2,000 ohms
10F/536	Switch, type 471	3	S _{1a} , S _{1b} , S _{1c}	Wafer S.P. 4-way
	Transformer			
10K/245	Type 363	1	T ₄	Microphone, 40 : 1
10K/246	Type 364	1	T ₅	A.F. output
10K/241	Transformer unit, type 29	1	T ₂	
	Fitted with—			
	Condenser			
10C/4328	Type 2233	2	C ₁₃ , C ₁₅	0.00015 μ F
10C/4329	Type 2234	1	C ₂₁	0.0001 μ F
	Resistance			
10C/11674	Type 508	1	R ₁₉	0.5 megohm
10C/1018	Type 1018	1	R ₁₈	2,000 ohms
10K/242	Transformer unit, type 30	1	T ₃	
	Fitted with—			
10C/4328	Condenser, type 2233	2	C ₁₃ , C ₂₂	0.00015 μ F
10C/1018	Resistance, type 1018	1	R ₁₈	2,000 ohms
	Valve			
10E/11399	Type V.R.53	2	V ₁ , V ₃	
10E/11401	Type V.R.55	1	V ₆	
10E/11402	Type V.R.56	2	V ₄ , V ₅	
10E/11403	Type V.R.57	1	V ₂	
	Transmitter unit, type 22	1	Fig. 2	T.R.1196 and T.R.1196A
	Principal components—			
10H/1151	Aerial-socket unit	1		Single-pole
10H/12865	Cap valve, type 12	2		
10C/2054	Choke, H.F. type 86	2	L ₁ , L ₄	

Ref. No.	Nomenclature	Qty.	Ref. in figure	Remarks
	T.R.1196 and T.R.1196A (<i>contd.</i>)			
	Transmitter unit, type 22 (<i>contd.</i>)			
	Principal components (<i>contd.</i>)—			
	Condenser			
10C/9755	Type 332	3	C ₄ , C ₅ , C ₈	0.01 μ F
10C/10512	Type 379	1	C ₁₃	0.001 μ F
10C/10551	Type 420	1	C ₃	20 μ μ F
10C/10832	Type 482	1	C ₁₀	1 μ F
	or			
10C/4572	Type 2382			
10C/11486	Type 537			
10C/244	Type 635	1	C ₂	0.0001 μ F
10C/499	Type 737	1	C ₁₁	0.01 μ F
10C/4323	Type 2228	2	C ₇	0.005 μ F
10A/12870	Disc, coupling	1	C ₆ , C ₁₂	0.0003 μ F
	Holder, valve			
10H/379	Type 62	1		9-pin for V ₁
10H/493	Type 73	2		Octal base for V ₂ , V ₃
	Indicator, visual tuning	1		
	<i>Fitted with—</i>			
5A/1117	Lamp filament, 2-v.	1	PL ₁	Resonance indicator
10C/6875	Resistance, type 6875	1	R ₁₀	10 ohms
	Inductance type 183	1	L ₂ , L ₃	Band-pass
10H/1523	Plug, type 360	1	TJP	6-pole
10F/720	Relay, magnetic, type 257	1	REL ₇ ^A	250-ohm, 1 c/o, 1 m.
10A/13094	Retainer, valve, type 19	1		
	Resistance			
10C/8019	Type 111	1	R ₁	100,000 ohms
10C/8021	Type 113	1	R ₅	20,000 ohms
10C/11379	Type 475	1	R ₂	20,000 ohms
10C/11381	Type 477	1	R ₈	50,000 ohms
10C/11499	Type 487	1	R ₄	100,000 ohms
10C/11668	Type 502	1	R ₁₁	2,000 ohms
10C/11674	Type 508	2	R ₇ , R ₉	0.5 megohm
10C/34	Type 551	1	R ₁₂	200 ohms
10C/1156	Type 1156	1	R ₆	500 ohms
10C/1862	Type 1862	1	R ₃	250 ohms
10F/536	Switch, type 471	3	S _{1a} , S _{1b} , S _{1c}	Wafer S.P. 4-way
10K/247	Transformer, type 365	1	T ₁	Modulation 1 : 1.25
	Valve			
10E/92	Type V.R.91	1	V ₁	
10E/11398	Type V.T.52	1	V ₃	
10E/389	Type V.T.501	1	V ₂	
	<i>The following items are included in the tuning coil section of the transmitter—</i>			
10R/37	Coil, aerial	4	L ₅ , L ₆ , L ₇ , L ₈	
10R/38	Contact, wheel	4		
10A/13261	Dial, revolution indicator	4		
	Knob			
10A/13263	Type 108	1		
10A/13264	Type 109	1		
10A/13265	Type 110	1		
10A/13266	Type 111	1		
	Rod			
10R/59	Aerial coil	4		
10R/40	Contact wheel	4		
10A/13262	Sheave assembly	4		
10R/41	Spring, tension, contact	4		
10R/50	Washer, spring	4		
	Chassis assembly, type 8		Fig. 5	T.R.1196A (12 volt)
	Principal components—			
	As chassis assembly, type 7, except—			
10D/373	Selector-drive unit	1		Substituted for 10D/550
	<i>Fitted with—</i>			
10C/10165	Condenser, type 386	1	C ₂	0.1 μ F
10D/501	Clutch	2		
10C/6069	Resistance, type 6069	1	R ₁	1 ohm

Ref. No.	Nomenclature	Qty.	Ref. in figure	Remarks
	T.R.1196 and T.R.1196A (<i>contd.</i>)			
	Power unit, type 104		Fig. 6	T.R.1196A
	Principal components—			
10K/567	As power unit, type 87, except—			
	Transformer, rotary, type 51	1		Substitute for 10K/568
	or			
10K/269	Transformer, rotary, type 257	1		Substitute for 10K/270
	Accessories—			Common to all installations
	Block, terminal, type B, No. 1	4		2-way
5E/916	Cable, L.T. unisheathcotton 4	As required		Aerial and earth lead
	Cable end			
5K/911	Eye type 4 B.A.	1		
5K/1839	Hook type crimping 2 B.A.	3		
10D/678	Case, transit			
10K/ as required	Crystal units	8		4-transmitter, 4 receiver
	Insulator			
10B/8093	Type 16	1		Aerial lead-in
	or			
10B/11457	Type 49	1		Aerial lead-in, dome shaped
	or			glass
	Special	1		Aerial lead-in
10B/8994	Type 18	1		Aerial strain type, tail fitting
10B/9121	Insulator, type 18, strand	1		
10F/7741	Key, morse, type F	1		
5K/1072	Sleeve, identification	3		
10H/625	Socket, type 199	1		Telephone microphone, jack type
5K/1058	Terminal, instrument spring, type No. 2 B.A.	1		Earth
10B/8235	Wire, aerial			
	Accessories—	As required		Stainless steel
				Peculiar to individual aero-planes
10H/1566	Connector set			
	Type T.R.1196/V	1		"Firefly", 24-volt
	Comprising—			
	Connector			
10H/895	Type 360/1	1		Form 4, 12-way
10H/896	Type 361/1	1		Dumet 4 and Duce1 4
10H/897	Type 362/1	1		Dumet 19
10H/1590	Type T.R.1196/AP	1		"Fulmar", 24-volt
10H/1591	Type T.R.1196A/E	1		"Swordfish", 12-volt
				(Torpedo trainer only)
10H/1592	Type T.R.1196/Z	1		"Blackburn" No. 11/40, 24-volt
10J/22	Controller, electric, type 4	1	Fig. 5	Press button operated
	Fitted with—			
10A/10495	Cap, lamp, type 1	5	PL _a , PL _b , PL _c , PL _d , PL _t	
10F/11777	Handle, switch	1		
10H/11661	Jack, lamp, type 1	5		
10A/11562	Knob, type 12	5	BS _a , BS _b , BS _c , BS _d , BS _o	
10J/63	Mask, lamp, type 3	1		
	Plug			
10H/395	Type W.202	1	P ₁	12-pole
10H/1917	Type 384	1	P ₅	2-pole
10H/1766	Socket, type 315	1		2-pole
	Switch			
10F/11564	Type 166	1	S ₃	T/RA/R
10F/776	Type 596	1		
	Accessories—			
5L/1141	Lamp, filament, 12 v.	5		Jack type, P.O. No. 2A
	or			
5L/1638	Lamp, filament, 24 v.	5		Jack type, P.O. No. 2A

SECTION 2, CHAPTER 9

TRANSMITTER-RECEIVER T.R.1161

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**CONCISE DETAILS OF
TRANSMITTER-RECEIVER T.R.1161**

PURPOSE OF EQUIPMENT	To provide two-way C.W. communication on multi-seater aeroplanes. Primarily designed for the Fleet Air Arm.		
TYPE OF WAVE	C.W.		
FREQUENCY RANGE	3 to 7 Mc/s.		
FREQUENCY STABILITY	Transmitter and receiver ± 0.1 per cent. at altitudes up to 40,000 ft. and temperature variations from $+30^{\circ}\text{C.}$ to -30°C. Normal conditions ± 0.03 per cent.		
CRYSTAL MULT. FACTOR			
PERCENTAGE MODULATION			
MAXIMUM SENSITIVITY	2 $\mu\text{V.}$ into dummy AE of 100 μF in series with 10 signal/noise of at least 12 db.		
SELECTIVITY	Not less than 3 kc/s wide 6 db. down. Not greater than 30 kc/s. wide 60 db		
OUTPUT IMPEDANCE			
AMPLIFIER CLASS			
MICROPHONE TYPE	A.M.		
VALVES	Transmitter V.T.60 2 (Stores Ref. 10E/11441) Oscillator doubler and power amplifier. Receiver V.R.91 5 (Stores Ref. 10E/92) R.F. amplifier, 1st oscillator frequency control, I.F. amplifier, C.W. oscillator, output 6K8G 1 (Stores Ref. 10E/406) Frequency changer. V.R.53 1 (Stores Ref. 10E/11399) I.F. amplifier. V.R.55 1 (Stores Ref. 10E/11401) Tone oscillator and signal and A.V.C. rectifier. Power unit V.S.68 1 (Stores Ref. 10E/11449) Stabiliser.		
POWER INPUT	Transmitting condition—key down 150 watts. Transmitting condition—mean power 125 watts. Receiving condition, 110 watts.		
POWER OUTPUT	Not less than 10 watts when working into 10 ohms and 100 μF artificial aerial. Input voltage 26 at battery input plug.		
STORES REF. No.	10D/256.		
APPROXIMATE OVERALL DIMENSIONS	LENGTH 16 $\frac{1}{2}$ in.	WIDTH 13 $\frac{1}{2}$ in.	HEIGHT 8 $\frac{1}{2}$ in.
WEIGHT	51 lb.		
ASSOCIATED EQUIPMENT	Control unit (Stores Ref. 10L/31) Cables.		

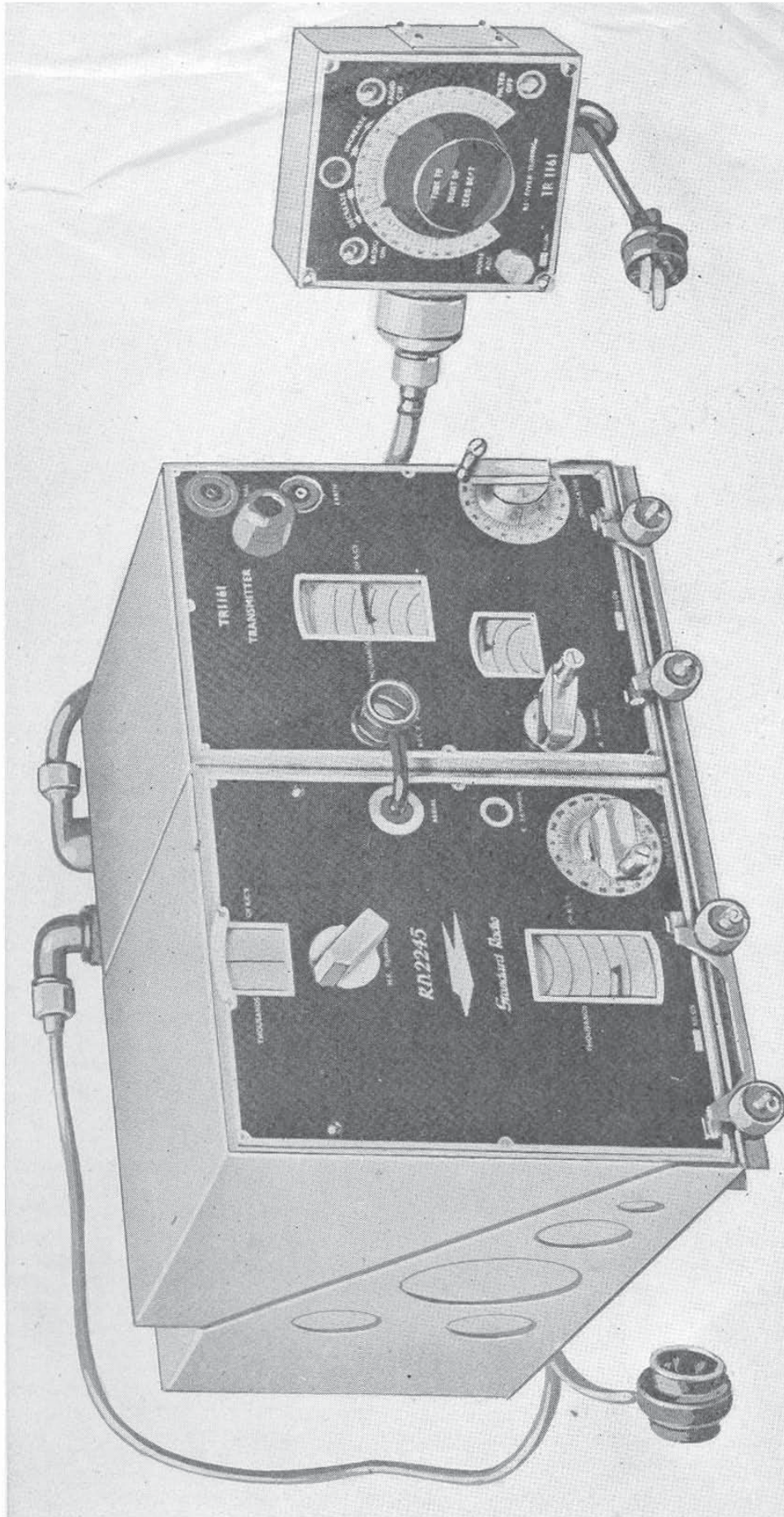
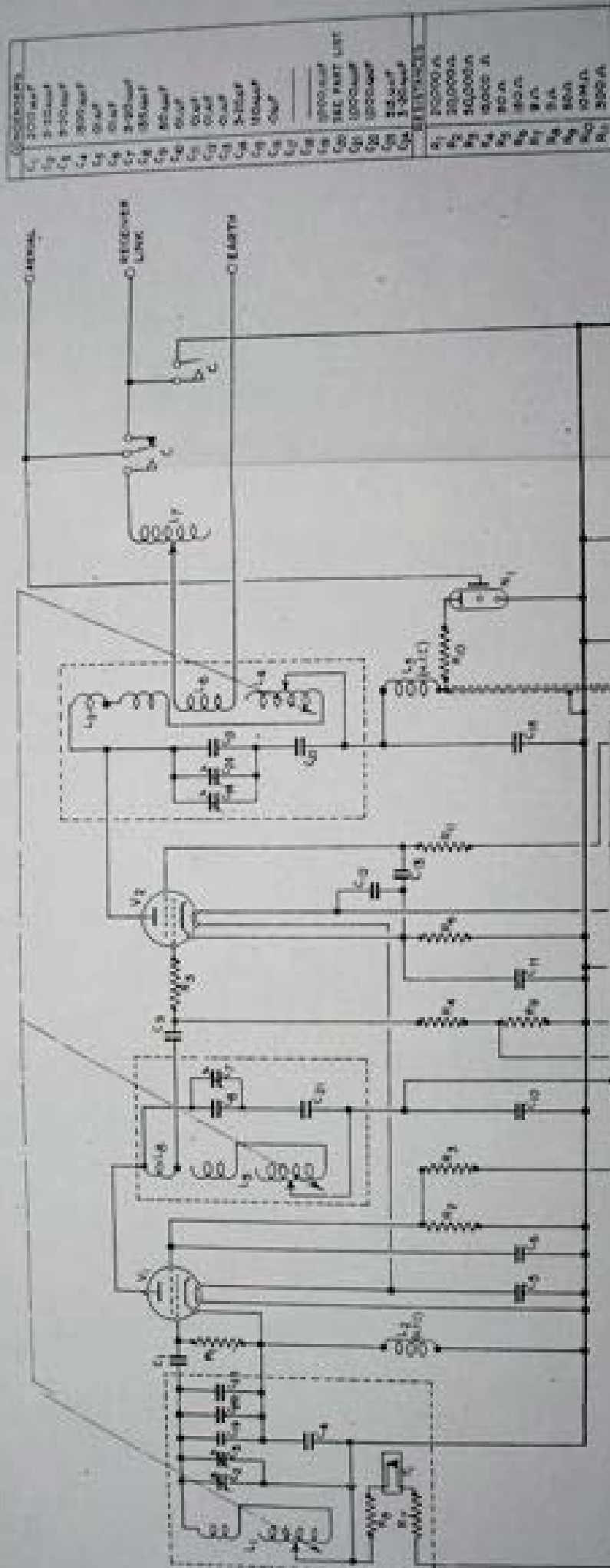


FIG. 1.—GENERAL VIEW OF T.R.1161 EQUIPMENT



TRANSMITTER CIRCUIT DIAGRAM

FIG 2

FIG.2

SECTION 2, CHAPTER 9

TRANSMITTER-RECEIVER T.R.1161

(Stores Ref. 10D/256)

INTRODUCTION

1 The transmitter-receiver T.R.1161 is a self-contained equipment designed to provide two-way C.W. communication on multi-seater fighter aircraft. Primarily intended for the Fleet Air Arm it operates in the 3 to 7 Mc/s band. Any frequency within the stated band may be preselected, and, if the controls are accessible, frequency can be changed during flight. The control of all operations, such as switching on, keying and trimming the receiver, is effected by a remote control located conveniently near the operator; the main unit, therefore, can be situated where it is accessible when the aeroplane is on the ground but not necessarily in the air. Features of the design are high stability and setting accuracy, the circuit elements being temperature compensated.

2. The equipment consists of two main units—(i) the main assembly, comprising the transmitter, receiver and power supply and (ii) the remote control unit. The two units are interconnected by one cable and two "W" plugs.

3. The transmitter comprises two stages, namely, an oscillator doubler stage and a power amplifier stage. The oscillator valve is employed in a circuit of the electron-coupled type with a Colpitts tuned circuit.

4. The receiver is an eight-valve superheterodyne using an intermediate frequency of 550 kc/s, provision being made for the electrical fine tuning of the frequency of the local oscillator section of the frequency changer from the remote control.

5. Power supply is obtained from a rotary transformer operating from the aeroplane general services. The secondary of the transformer provides two outputs—12 volts for the L.T. and 350 volts for the H.T. The input required is 24 volts.

6. The power output from the transmitter is 10 watts into the aerial circuit. The sensitivity and signal-noise ratios are such that under normal conditions an unmodulated signal of 1 to 2 microvolts into an aerial of 10 ohms $100\mu\text{F}$ will give an output of at least 50 mW. with a signal/noise ratio of 12 db.

7. The dimensions of the main unit are $8\frac{1}{4}$ in. high by $13\frac{1}{2}$ in. wide by $16\frac{1}{4}$ in. long. The control unit measures $4\frac{7}{8}$ in. by $4\frac{3}{8}$ in. by $2\frac{1}{4}$ in. The total weight is 51 lb., exclusive of cabling. A view of the complete equipment is given in fig. 1. It should be noted that in the circuit diagrams and photographs which follow, the annotational references are upwards for each unit.

GENERAL DESCRIPTION

Transmitter

8. A theoretical circuit diagram of the transmitter is given in fig. 2 and it will be seen that it consists of an oscillator-doubler stage and a power amplifier stage. The circuit of the oscillator valve V_1 is of the electron-coupled type with a Colpitts tuned circuit consisting of condensers C_2 , C_3 , C_4 , C_{19} , C_{20} and C_{23} and inductance L_1 connected between the screen grid and control grid, via condensers C_1 and C_6 . A further tank circuit, consisting of C_7 , C_8 and C_{21} and inductance L_3 , tuned to double the oscillator frequency, is employed in the anode circuit so as to obtain adequate output and reduce pulling of the oscillator to the minimum. In order to compensate for temperature variations and reduce frequency drift to a minimum, the oscillator tuning circuit is made up of positive and negative temperature coefficient condensers. In addition, the oscillator inductance L_1 and condensers are enclosed in a screened can which is heat insulated; this compartment is also provided with a thermostatically controlled heater R_7 , R_8 and T_1 to maintain the chamber at a temperature of approximately 30°C . Power for the heater is obtained from the 12 volt secondary winding of the rotary transformer unit.

9. The oscillator valve V_1 is coupled to the power amplifier V_2 by the condenser C_9 and the resistances R_5 , R_4 and R_9 . The anode tank circuit of the amplifier C_{14} , C_{15} , C_{22} and C_{24} and coil L_4 is tuned to the same frequency as the anode circuit of the oscillator. The grid bias supply for the power amplifier valve is obtained from the rectified grid current via the grid leak R_4 and R_9 .

10. The three tuned circuits (oscillator, oscillator anode and harmonic generator, and power amplifier anode) are mechanically coupled, but are at the same time electrically screened from one

CONDENSERS

C 1	TUNER	C 35	115 μ F
C 2	TUNER	C 36	0.1 μ F
C 3	3-25 μ F	C 37	0.1 μ F
C 4	12-42 μ F	C 38	0.1 μ F
C 5	0.1 μ F	C 39	115 μ F
C 6	0.1 μ F	C 40	12-42 μ F
C 7	0.1 μ F	C 41	12-42 μ F
C 8	0.1 μ F	C 43	50 μ F
C 9	0.1 μ F	C 44	20 μ F
C 10	0.1 μ F	C 45	0.1 μ F
C 11	0.1 μ F	C 46	0.0002 μ F
C 12	0.1 μ F	C 47	0.0001 μ F
C 14	3.5-25 μ F	C 48	0.1 μ F
C 15	0.00025 μ F	C 49	8 μ F
C 16	50 μ F	C 50	0.1 μ F
C 17 ^A	500 μ F	C 51	0.15 μ F
C 17 ^B	440 μ F	C 52	0.05 μ F
C 18		C 53	0.001 μ F
C 19		C 54	0.1 μ F
C 20	50 μ F	C 55	25 μ F
C 21	0.1 μ F	C 56	0.1 μ F
C 22	0.1 μ F	C 57	0.1 μ F
C 23	0.1 μ F	C 60	320 μ F
C 24	115 μ F	C 61 ^A	100 μ F
C 25	12-42 μ F	C 61 ^B	80 μ F
C 26	12-42 μ F	C 61 ^C	40 μ F
C 27	115 μ F	C 61 ^D	20 μ F
C 28	0.0005 μ F	C 62 ^A	100 μ F
C 29	0.1 μ F	C 62 ^B	80 μ F
C 30	0.1 μ F	C 62 ^C	40 μ F
C 31	0.1 μ F	C 62 ^D	20 μ F
C 32	115 μ F	C 63	0.1 μ F
C 33	12-42 μ F	C 64	0.02 μ F
C 34	12-42 μ F	C 65	0.02 μ F
		C 66	0.015 μ F

RESISTANCES

R 1	100,000 Ω
R 2	300 Ω
R 3	1,000 Ω
R 4	15,000 Ω
R 5	50,000 Ω
R 6	100 Ω
R 7	50,000 Ω
R 8	500 Ω
R 10	5,000 Ω
R 11	15,000 Ω
R 12	100 Ω
R 13	25,000 Ω
R 14	50,000 Ω
R 15	100,000 Ω
R 16	500 Ω
R 17	50,000 Ω
R 18	50,000 Ω
R 19	100,000 Ω
R 20	500 Ω
R 21	100,000 Ω
R 22	50,000 Ω
R 23	25,000 Ω
R 24	$\frac{1}{4}$ M
R 25	50,000 Ω
R 26	220,000 Ω
R 27	10,000 Ω
R 28	30,000 Ω
R 29	50,000 Ω
R 30	25,000 Ω
R 31	$\frac{1}{4}$ M Ω
R 32	$\frac{1}{2}$ M Ω
R 33	50,000 Ω
R 34	$\frac{1}{2}$ M Ω
R 35	300 Ω
R 36	10,000 Ω
R 37	50,000 Ω
R 38	150,000 Ω
R 39	4 Ω
R 40	4 Ω
R 41	4 Ω
R 42	300 Ω

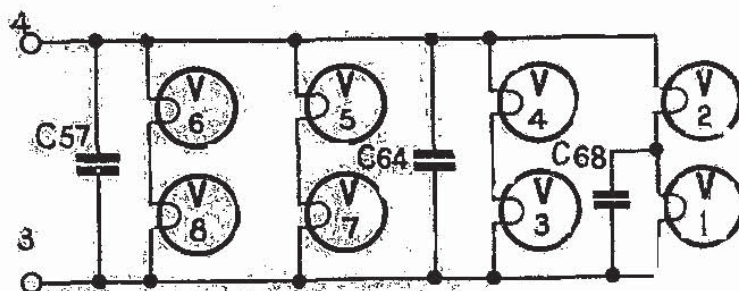


FIG. 3

another to prevent interaction and give maximum stability. The inductance of each of these coils is the same, each being split up into two mutually coupled portions, one with thick wire which is always in circuit and the other with a thinner wire on which a roller contact can be moved to provide a variation of the inductance in circuit.

11. The aerial circuit, which is tuned by the inductance L_7 , is inductively coupled by means of the small coupling coil L_8 to the amplifier tank circuit. This coupling coil is situated between the variable and fixed parts of the amplifier coil. The aerial circuit is designed to work into an aerial of which the effective capacitance is not less than $70 \mu\mu\text{F.}$ at 3 Mc/s and not more than $200 \mu\mu\text{F.}$ at 7 Mc/s. The effective resistance of the aerial may be between 1 and 10 ohms. These capacitances correspond to a short fixed aerial approximately 10 ft. long or to a fairly long fixed aerial 25 ft. in length, the limiting factor being that the aerial tends to become resonant when its length is equal to a quarter of the operating wavelength.

12. An R.F. indicator is mounted on the front panel, to check the radiation of the transmitter. This also indicates whether H.T. is applied to the final stage. The indicator takes the form of a small neon lamp mounted near the aerial terminal. The lamp has a D.C. polarising voltage applied to it from the 350-volt H.T. supply through R_{10} , fig. 2. The intensity of glow of the lamp is greatest at the low-frequency end of the band, so that its brightness is no indication of the amount of R.F. power being radiated. The indicator is, however, sufficiently sensitive to tune the transmitter. The transmitter is keyed by making and breaking the H.T. supply to the screen and anode of the oscillator valve and the screen of the power amplifier.

Receiver

13. Eight valves are employed in the receiver in a superheterodyne circuit which is given in fig. 3. The intermediate frequency used is 550 kc/s. The valve sequence is as follows:—

V_1 , H.F. amplifier; V_2 , frequency changer; V_3 , 1st oscillator frequency control; V_4 , I.F. amplifier; V_5 , I.F. amplifier; V_6 , C.W. oscillator; V_7 , tone oscillator, signal and A.V.C. rectifier; V_8 , output.

14. In the aerial circuit is a trimming condenser C_3 which, within normal limits of aeroplane antennae, permits of the antenna circuit being tuned to resonance. The H.F. transformer design is essentially a compromise between gain and selectivity and the constants are chosen to give maximum stage gain consistent with minimum detuning errors. Condensers C_1 and C_2 are ganged, so that the input and output circuits of V_1 are tuned simultaneously.

15. The frequency-changer valve V_2 , fig. 3, is operated at maximum gain and, in conjunction with the beating oscillator, converts the received signal to 550 kc/s. The triode portion of this valve employs a Colpitts type oscillator. To ensure constancy of the oscillator circuits, which would vary with change of temperature, resulting in frequency drift, the components of this stage are contained in a screened box lagged with cork and the heat supplied by R_{39} , R_{40} and R_{41} is controlled by a thermostatic relay. Compensation for changes of ambient temperature is also afforded by a combination of ceramic and mica insulation for the tuning condensers C_{17a} , C_{17b} , C_{18} , C_{19} , C_{21} and C_{22} . The frequency drift, due to change of coil inductance with change of temperature, is thus reduced to an amount which, under normal operating conditions, is within the audible range and occurs over a minimum period of time.

16. The first oscillator frequency control valve, V_3 , has its cathode brought out to a variable resistance R_4 in the remote control unit, which enables the amplification of the valve to be varied and, in conjunction with the associated circuits, C_{20} , R_{10} and R_{13} , varies the input impedance between C_{16} and earth. This impedance, which is mainly capacitive, is connected *via* C_{16} , between the oscillator anode of V_2 and the chassis, so that, as the gain of V_3 is changed, the frequency of the beating oscillator also varies. The amount of control is small, but the frequency deviation obtainable is sufficient to compensate for slight drift or inaccuracy of dial setting. Too wide a control is not desirable, as it would make the location of a particular signal difficult because of the additional number of signals received with wider frequency variation.

17. The intermediate-frequency amplifier, which is tuned to 550 kc/s., employs five tuned circuits in cascade, viz. L_4 , L_5 and L_6 together with the associated tuning condensers, as indicated in the circuit diagram. The amplifier valves are V_4 and V_5 . To overcome the variation of input impedance due to change of grid-cathode capacitance, the grid circuits of V_4 and V_5 are connected across only a part of the total coil and, in addition, each tuned circuit is loaded with fixed capacitance, leaving a small ceramic condenser to tune these circuits to resonance. The tuning condensers are C_{25} , C_{26} , C_{33} , C_{34} and C_{40} . The temperature coefficient of the I.F. tuning capacitances is selected to give the minimum frequency drift and thus improve gain stability.

18. Slight negative feedback reduces the gain of the amplifier valve V_4 , and this improves stability, reduces noise and makes for a better automatic gain control characteristic. The feedback, or degeneration, in this stage is due to a particular choice of the cathode by-pass condenser, C_{28} .

19. The oscillator valve V_6 , and part of L_6 which works only at a fixed frequency, is compensated against frequency drift and, therefore, with compensated oscillators and a scale specially designed for high setting accuracy, the receiver may be set to any frequency within its range with the certainty that the signal will be heard.

20. The output of the I.F. amplifier is fed into one of the diodes of V_7 *via* the coupling windings L_8 and the C.W. oscillator is injected in series with the I.F. amplifier output. The resultant audio-frequency voltage, due to detection, appears across the diode load R_{24} and filter condenser C_{46} and is fed, *via* a low-pass filter R_{25} , C_{47} , to the grid of the output valve V_8 where R_{24} functions as an audio-frequency volume control.

21. The valve V_7 also functions as a side tone oscillator on "Transmit" in the following manner. With the transmitter key depressed, H.T. voltage is placed between terminal 9 (marked Tone Osc. in the circuit diagram) and chassis. This causes the triode portion of V_7 , together with the associated circuits L_7 , C_{51} , C_{50} , and C_{52} , R_{31} , to oscillate at a frequency of approximately 850 cycles. This audio-frequency tone appears across C_{53} and chassis *via* the side tone output volume control R_{32} .

22. The output valve V_8 , is operated for maximum gain and the transformer T_1 serves to isolate the headphones from D.C. H.T. and to provide matching into an impedance of 7,000 ohms, corresponding to high resistance phones, or into low-resistance phones approximating to 200 ohms impedance.

23. The automatic gain control circuit in the receiver is derived from the rectified carrier output from the diode circuit of V_7 . This voltage appears across R_{29} and is fed *via* the low-pass filter R_{30} , C_{54} to controlled valves V_5 , V_4 and V_1 . The time constant of the A.V.C. system is determined principally by R_{30} , C_{54} , C_{63} and the associated decoupling resistances and condensers of the controlled stages. Resistances R_{27} and R_{28} form a voltage delay network to ensure that the rectified bias voltage across R_{29} does not come into operation until a certain carrier strength is reached. A by-pass condenser C_{49} short-circuits the tone oscillator voltage developed across R_{27} ; complete control of side tone output is, therefore, *via* R_{33} only.

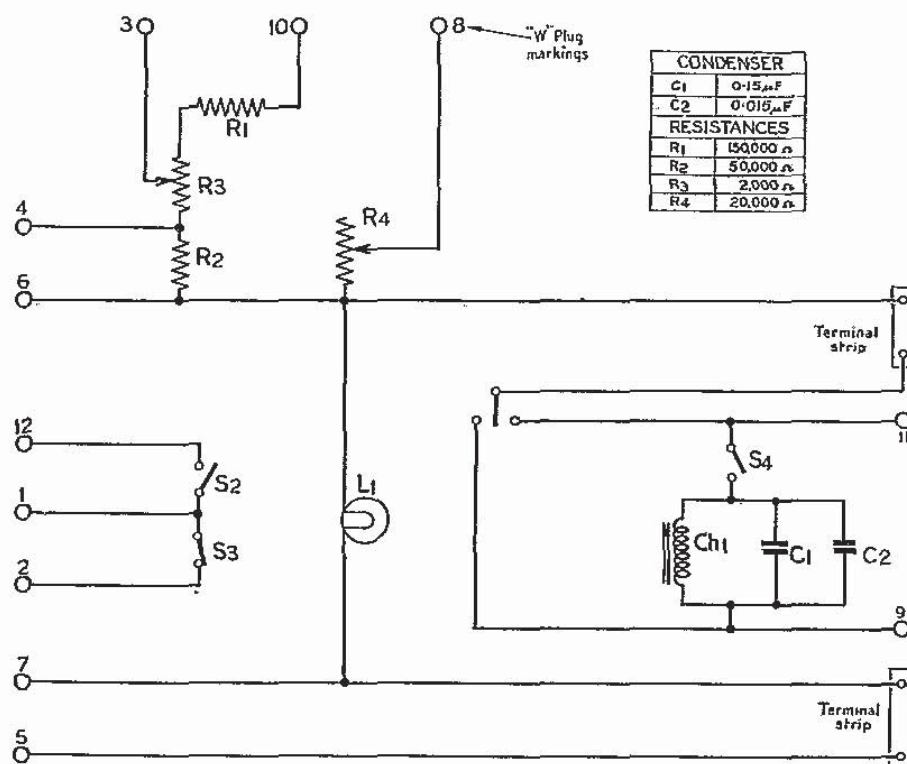
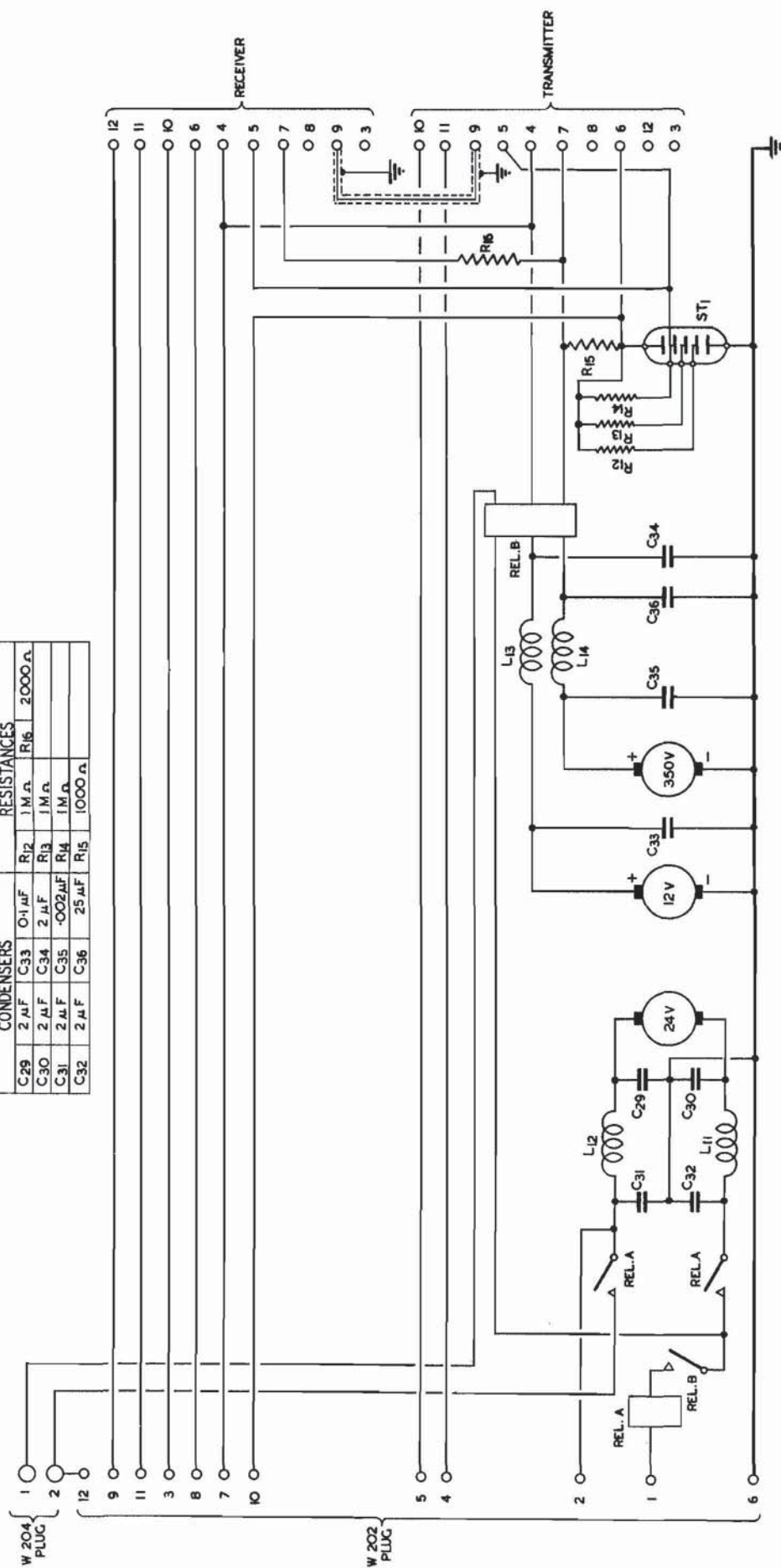


FIG. 4.—CONTROL UNIT CIRCUIT DIAGRAM

Control unit

24. The circuit diagram of the control unit is given in fig. 4. Reference to this will show that the phone output may be connected *via* S_1 between terminal 6 (earth) and either terminals 11 or 9, according to the output impedance required. Across these terminals is connected a note filter circuit (Ch_1 and C_1 (fig. 4)), which resonates at approximately 850 cycles but gives a sharp cut-off to frequencies either side of the resonant frequency. The filter may be switched out of circuit by S_4 .

CONDENSERS				RESISTANCES			
C29	2 μ F	C33	0.1 μ F	R12	1 M Ω	R16	2000 Ω
C30	2 μ F	C34	2 μ F	R13	1 M Ω		
C31	2 μ F	C35	0.02 μ F	R14	1 M Ω		
C32	2 μ F	C36	25 μ F	R15	1000 Ω		



POWER UNIT CIRCUIT DIAGRAM

25. Noise reduction is effected by a variable resistance R_3 . This resistance which gives control of sensitivity is connected *via* terminal 10 to the cathodes of V_1 and V_5 through the series resistances R_1 and R_{20} of the receiver (fig. 3). The condensers C_{11} , C_{12} and C_{63} tie the interconnecting service leads to the chassis at R.F. potential.

26. Break-in keying is achieved by muting the receiver during keying intervals. It will be seen by reference to fig. 4 that R_2 is in series with R_3 to the chassis so that on TRANSMIT, R_2 , which is connected to the SEND-RECEIVE relay in the transmitter, is open-circuited and additional bias is switched into the cathodes of valves V_1 and V_5 of the receiver, thus desensitising it. In addition, the aerial terminal of the receiver is short-circuited to chassis. These operations are arranged to occur before the H.T. is connected to the transmitter by special adjustment of the change-over relay.

Power supply

27. The rotary transformer which supplies all power for the equipment has a 24-volt input derived from the aeroplane general services. The circuit is given in fig. 5. The outputs are 12-volts L.T. and 350 volts H.T. Filtering arrangements are included in both input and output leads; the input comprises L_{11} , L_{12} , C_{29} , C_{30} , C_{31} and C_{32} ; the 12-volt output L_{13} , C_{33} and C_{34} and the 350-volt output by L_{14} , C_{35} and C_{36} . The 350-volt output is applied direct to the power amplifier of the transmitter and through dropping resistances to the receiver anodes and a stabilo-volt stabilising valve ST_1 to provide two stabilised supplies—one at 270 volts for the transmitter oscillator valve (anode and screen) and power amplifier screen, and the other at 220 volts for the receiver screen supplies.

28. The overload relay has three windings which are connected in series with the input and output of the rotary transformer; if the current in any of these circuits exceeds the safe limit, the relay operates and opens the energizing circuit of the starter relay, thus shutting down the entire equipment. It is designed to operate on the following loads:—

- (i) Input short circuit
- (ii) 12-volt secondary, 4.5 amps.
- (iii) 350-volt secondary, 450 mA.

It does not, however, protect against short circuits in the smoothing networks on the secondary side.

CONSTRUCTIONAL DETAILS

General

29. A view of the complete transmitter-receiver T.R.1161, split up into its component units, is given in fig. 6. It will be seen that it consists of an assembly comprising the transmitter, the receiver and the power supply unit, each of which is easily detachable from a mounting tray. The latter is a light-gauge sheet steel wedge-shaped tray designed for mounting on six shock absorbers which will each carry 8 lb., and the units can be released by unscrewing four knurled clamping nuts at the front and turning the two adjacent knobs on the transmitter and receiver to a vertical position, when the transmitter and receiver can be withdrawn by means of the extractor handles. The power unit can be removed by pulling up the two plunger type catches, turning through 90° and then releasing the two Dzus catches.

Transmitter

30. The transmitter consists of a shallow rectangular chassis on the upper side of which are mounted a three-gang coil assembly, the aerial coil, the valves and the front panel, as will be clearly seen by reference to fig. 7. In this view the three-gang coil assembly can be seen on the right, the aerial coil on the front left-hand corner behind the front panel and the valves behind this. A Jones plug for connection to the rotary unit is at the back of the chassis.

31. On the underside of the chassis are the screened compartments containing the oscillator components, the circuit components and the keying relay. The chassis is made of a light gauge sheet steel cadmium plated and welded. On the right-hand side is a step 1½ in. deep and 3 in. wide. The whole assembly fits into a light-gauge steel case and is fixed by a single Dzus fastener at the rear. The overall dimensions are 10 in. by 6 in. by 8 in.

32. The three-gang coil assembly has a box-form base of light-alloy, inside which is a horizontal shaft carrying the spiral gears for driving the three coils. The gear ratio between the horizontal shaft and the coils is 2.53 to 1. The three main tuning inductances are each mounted vertically on the base. The bottom bearing is a ball race fixed in an adjustable housing on the casting. Four cast aluminium pillars support the end plate which carries the top bearing of each coil, which is a plain brass bush. The coil spindle is hollow and the end of the coil is brought through it to a slip ring to which contact is made by a spring wire. The tuning condensers are mounted on brackets fixed to the end plates.

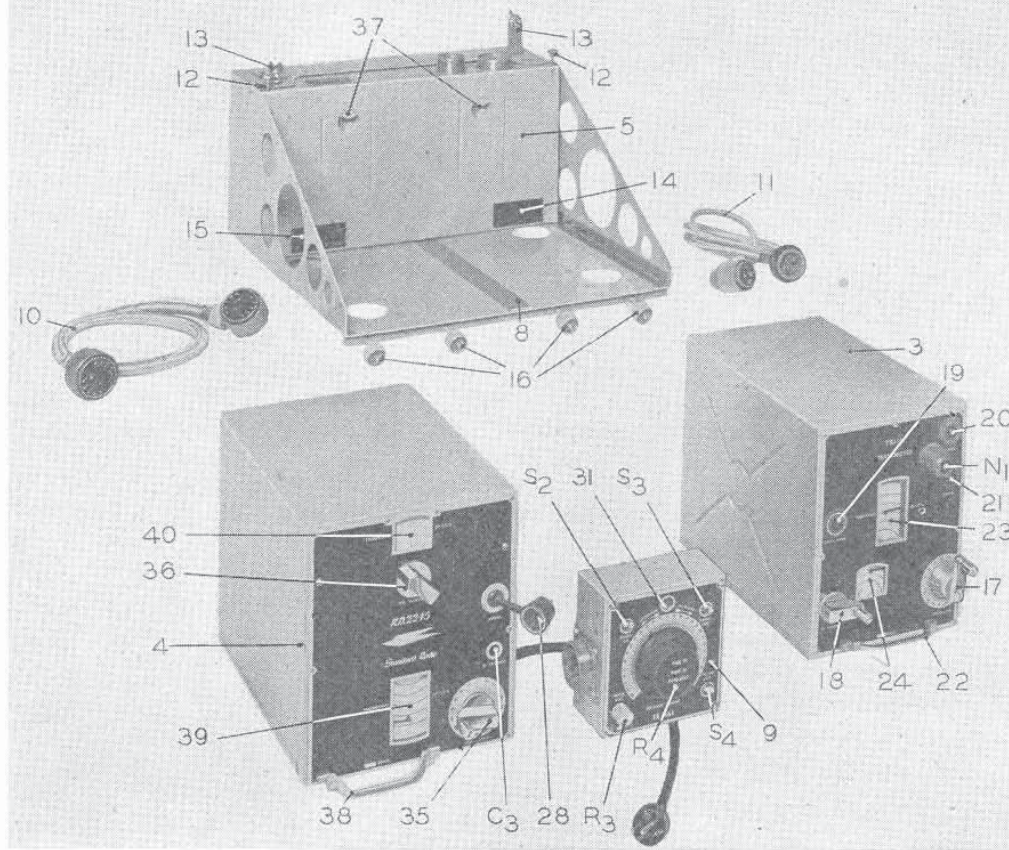


FIG. 6.—DISSEMBLED VIEW OF T.R.1161 EQUIPMENT

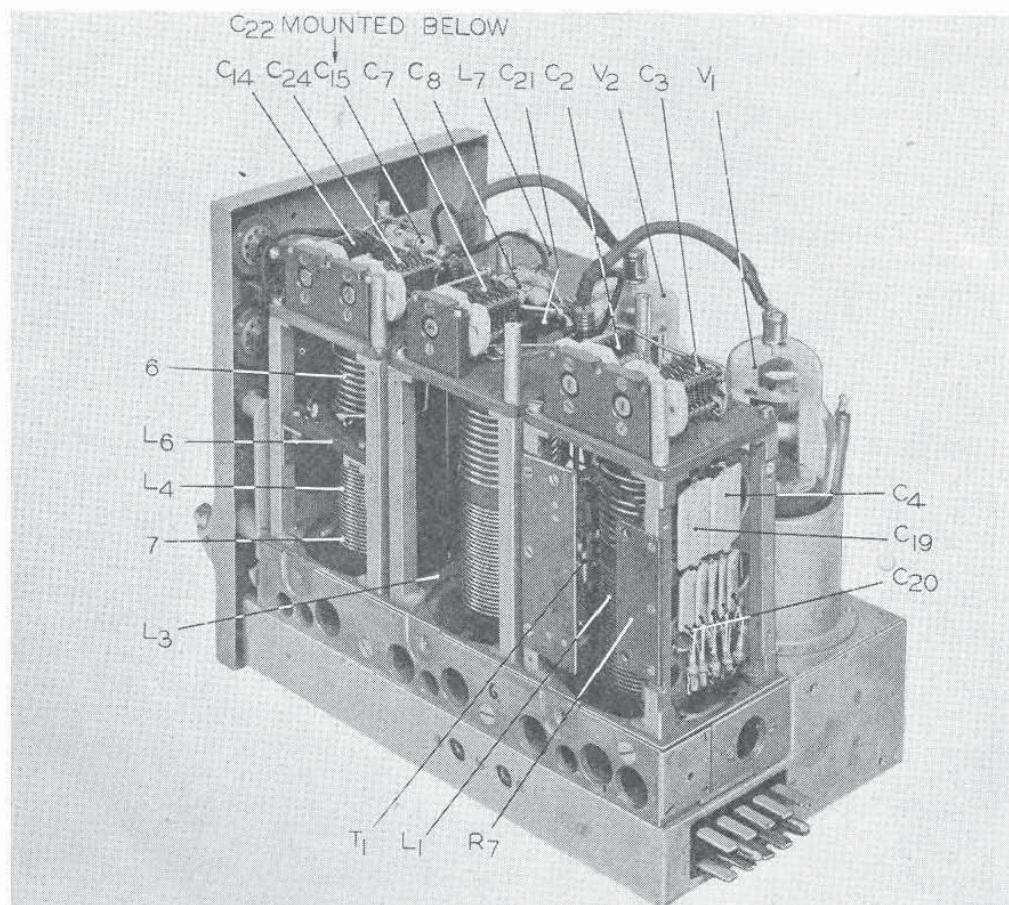


FIG. 7.—VIEW OF TRANSMITTER REMOVED FROM ITS CASE

33. The three coils are each screened with rectangular sheet aluminium boxes, the box covering the oscillator coil being lagged with cork encased in silk in order to maintain a constant temperature. On the sides of two of these cans are mounted the adjustable valve retaining flaps.

34. The coils consist of two mutually coupled inductances, one made of thick wire which is always in circuit, and the other of thinner wire, the number of turns in circuit being variable by means of a roller contact. The three coils are identical.

35. The front end of the horizontal driving shaft is geared to a 5 in. diameter scale. At the back of this scale is cut a scroll in which the radial change of the last $\frac{1}{2}$ in. is greater than the remainder. A guide pin runs in the scroll and is connected to a system of links which operate the pointer and stop mechanism. When the guide is at the end of the scroll, the stop mechanism comes into operation by means of the link movement which causes a lever to engage on a stop on the horizontal shaft. This spiral scale gives a high degree of setting accuracy as it corresponds to a scale approximately 50 in. in length.

36. The aerial coil is a complete assembly in itself. It consists of a light U-shaped casting which carries a horizontal shaft driving the vertical aerial coil by gears having a gear ratio of 1.2 to 1. The bearings are similar to those of the three-gang assembly, the stop being on the coil. The total length of the aerial scale is 14 in.

37. The front panel is fixed to the chassis by the pull-out handle and screws. Mounted on the panel are a neon radiation indicator lamp and the three sockets for the aerial, earth and receiver link.

38. Behind the panel are mounted the two small dials, the larger one for the oscillator tuning on the three-gang coil assembly and the small one for the aerial tuning. Both dials are calibrated in kilocycles. In order to obviate damage to the coil if undue force is used when the coils have reached the stop positions, the knobs are fitted with a slipping clutch which will re-engage upon reversal of rotation.

Receiver

39. The receiver is contained in a light steel box. A view of it removed from this is given in fig. 8. The front panel is secured to the case by a spring catch located at the rear of the case.

40. The main chassis (42) fig. 8 consists of a light steel box structure flanged and ribbed to give mechanical stability. A light angle framework (45) protects the components on the upper side and permits of the receiver being placed on its back to obtain easy access to the components on the underside. A central steel partition passes down the centre of the chassis which provides screening between the H.F. and L.F. circuits and also increases the mechanical rigidity.

41. The front panel is secured to the chassis by means of the pull-out handle and screws. There are two cut-outs in it through which the oscillator and H.F. tuning dials can be observed.

42. The H.F. coils are of the iron dust type and are mounted in a framework within their cans. The coils are tuned by means of variable ceramic condensers mounted just below the tops of the coil cans. The variable H.F. oscillator coil, L_3 , fig. 3, is mounted in a removable aluminium box, (41) fig. 8, at the lower left-hand side of the chassis. This coil is of the variable inductance type and consists of a wound former which can be rotated by a handle; this causes a carriage bearing the variable tapping point contact to move up and down the coil, contact being made by the drive pulleys with the winding on the former. The carriage is located in an angular plane by a guide rail which engages the guide blocks forming part of the carriage assembly.

43. The block of ceramic or silvered mica condensers for the purpose of adjusting the temperature drift of the coil is mounted on the side of the coil can opposite to the guide rail. The lead-out from the back of the coil is taken via spring wires which contact the slip ring on the rear spindle. A thrust spring is fitted to eliminate end play.

44. The oscillator scale is driven by a split gear mounted on the oscillator coil spindle, special precautions having been taken to eliminate back lash. The scale is of spiral form and it has an effective length of 55 in. allowing of a high degree of setting accuracy being obtained.

45. The H.F. circuits are tuned by the two gang condensers C_1 and C_2 ; the scale is mounted directly on the spindle, as a high setting accuracy for these circuits is not necessary. Undesired movement of the condenser is prevented by means of a friction disc and spring.

46. The two preset potentiometers for adjustment of L.F. volume and side tone volume are mounted adjacent to the ganged condensers on the top of the chassis.

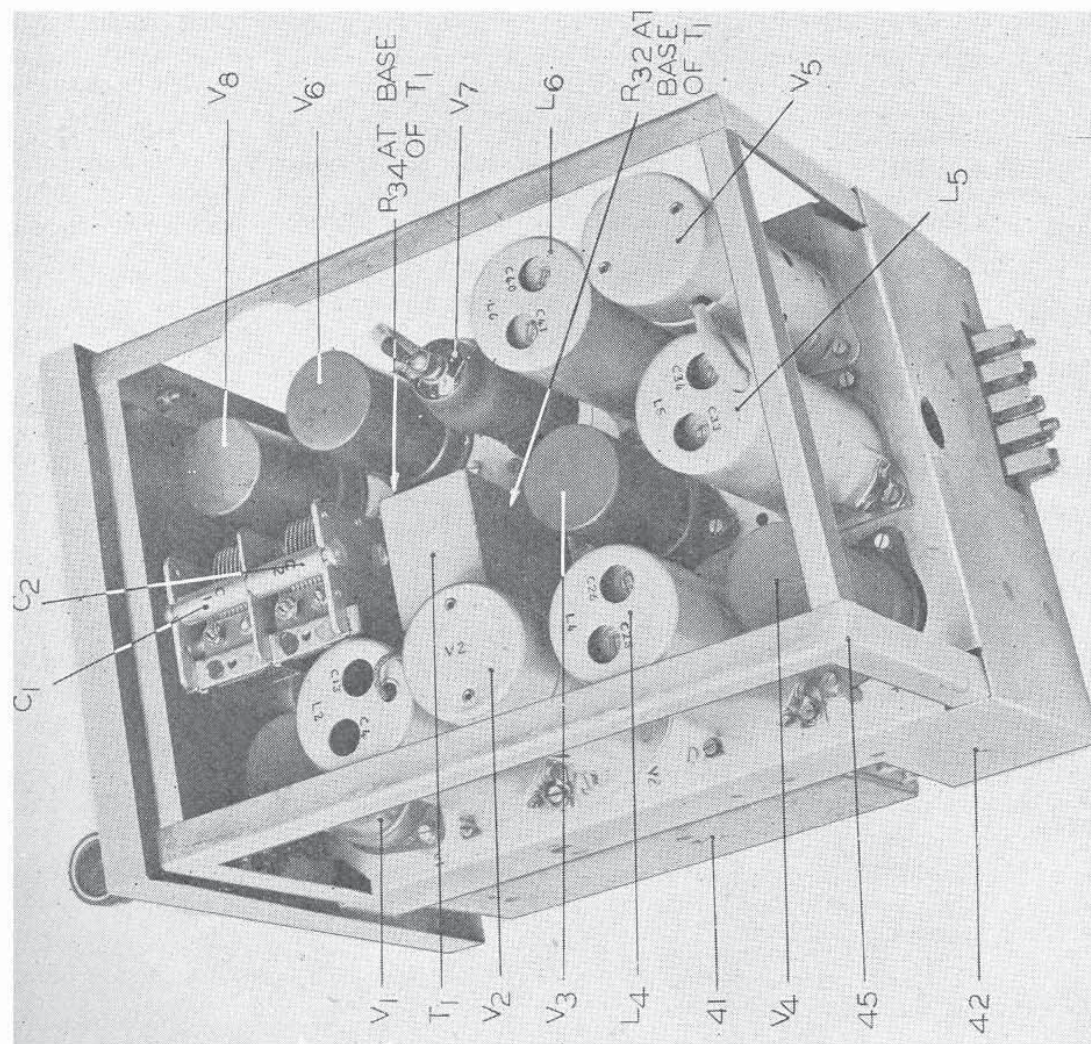


FIG. 8.—VIEW OF RECEIVER REMOVED FROM ITS CASE

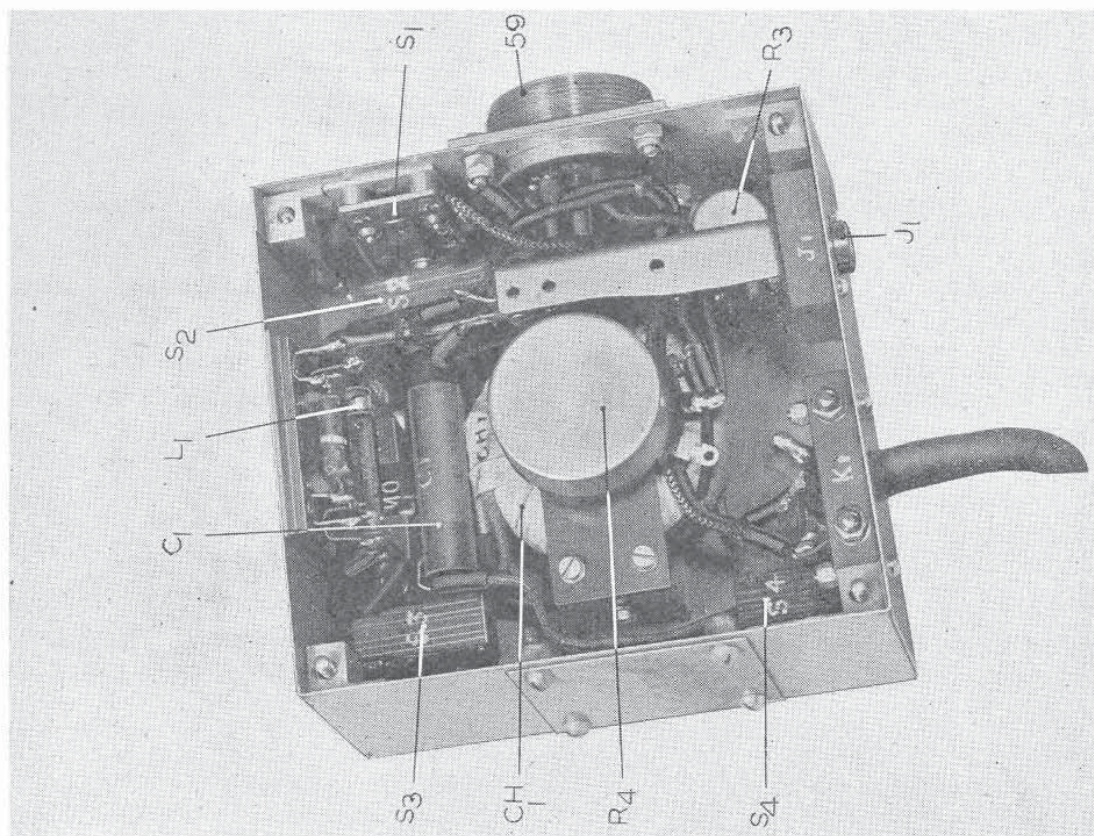


FIG. 9.—VIEW SHOWING INTERIOR OF CONTROL UNIT

47. The V.R.91 valves are held in their sockets by spring steel clips, V.R.55 and V.R.53 (V_5 , V_7) by screwed on valve caps, and the 6K8G (V_2) by an internal spring in the cap, which holds ears in the cap in engagement with straps mounted on the adjacent coil cans.

Control unit

48. The control unit consists of a rectangular metal box $4\frac{1}{2}$ in. long by $4\frac{7}{8}$ in. wide and $2\frac{1}{2}$ in. high with a detachable back plate which is slightly larger than the box to permit of mounting by three external screws. A view of this unit is given in fig. 9.

49. On the front panel of the control unit are the RADIO ON switch, RADIO OFF switch, ON indicator window, RECEIVER TUNING (fine frequency control), NOISE ADJUSTMENT control and FILTER ON-OFF SWITCH (audio frequency). The headphones and key leads are brought out at the bottom of the unit. All connections are made to a 12-point "W" plug into which fits the 12-point socket from the power supply unit.

50. Keying is effected by a contact on the aerial changeover relay in the transmitter. This performs the following operations in the sequence given; earths the receiver aerial, desensitizes the receiver, changes the aerial from receiver to transmitter, causes the triode section of the double-diode triode valve to oscillate at approximately 850 cycles on the side tone, applies H.T. to the transmitter oscillator anode and screen of the power amplifier.

Power supply unit

51. A rear view of the power supply unit is given in fig. 10. The chassis of this unit has a raised platform at the rear, on the top of which is mounted the rotary transformer, the voltage stabilizer and the various chokes and condensers employed in the smoothing circuit. These smoothing elements are mounted as near as possible to the rotary transformer, the latter being near the L.F. end of the receiver when the units are assembled on the main tray.

52. The rotary transformer is completely screened when in position. It is fixed to a small sub-tray which bolts on to a shallow sub-chassis. It has three commutators—a 24-volt input (primary) and 12-volt and 350-volt secondaries. The machine is shunt wound, the field winding being connected across the 24-volt input. A fan is fitted at the end of the shaft for cooling purposes.

53. On the underside of the platform are mounted the starter relay, the overload relay, the receiver socket, the transmitter socket and the various resistances, condensers, etc. indicated in the circuit diagram (fig. 5).

54. At the top of the chassis are mounted the control unit cable plug, the battery cable plug and the catch knobs and catches. The rotary unit is approximately 13 in. long by 6 in. deep by 7 in. high. A panel is provided on the long side, on the bottom of which are fitted the sockets for receiving the plugs on the transmitter and receiver; on the top are two W plugs for connection of the battery and control cables. When removed from the main tray the rotary unit is in the form of sub-chassis and panel, the enclosure being completed when in position in the main assembly.

VALVES AND POWER SUPPLY

55. The complete equipment incorporates eleven valves, one of which is a Stabivolt stabilizer valve; one neon lamp and an indicator lamp.

56. The transmitter has two valves, an oscillator doubler and a power amplifier, both of which are type V.T.60.

57. The receiver employs eight valves; V_1 , the R.F. amplifier is a type V.R.91; V_2 , the frequency changer, a type 6K8G; V_3 , 1st oscillator frequency control, a type V.R.91; V_4 and V_5 , I.F. amplifiers, types V.R.91 and V.R.53; V_6 , C.W. oscillator, type V.R.91; V_7 , tone oscillator, and signal and A.V.C. rectifier, type V.R.55; V_8 , output, type V.R.91.

58. The stabilizer Stabivolt valve incorporated in the power unit is a type V.S.68.

59. Power is obtained from the 24-volt aeroplane battery which drives the rotary transformer giving two separate outputs of 12 volts and 350 volts. Conversion to 12-volt operation may be made by changing the rotary transformer.

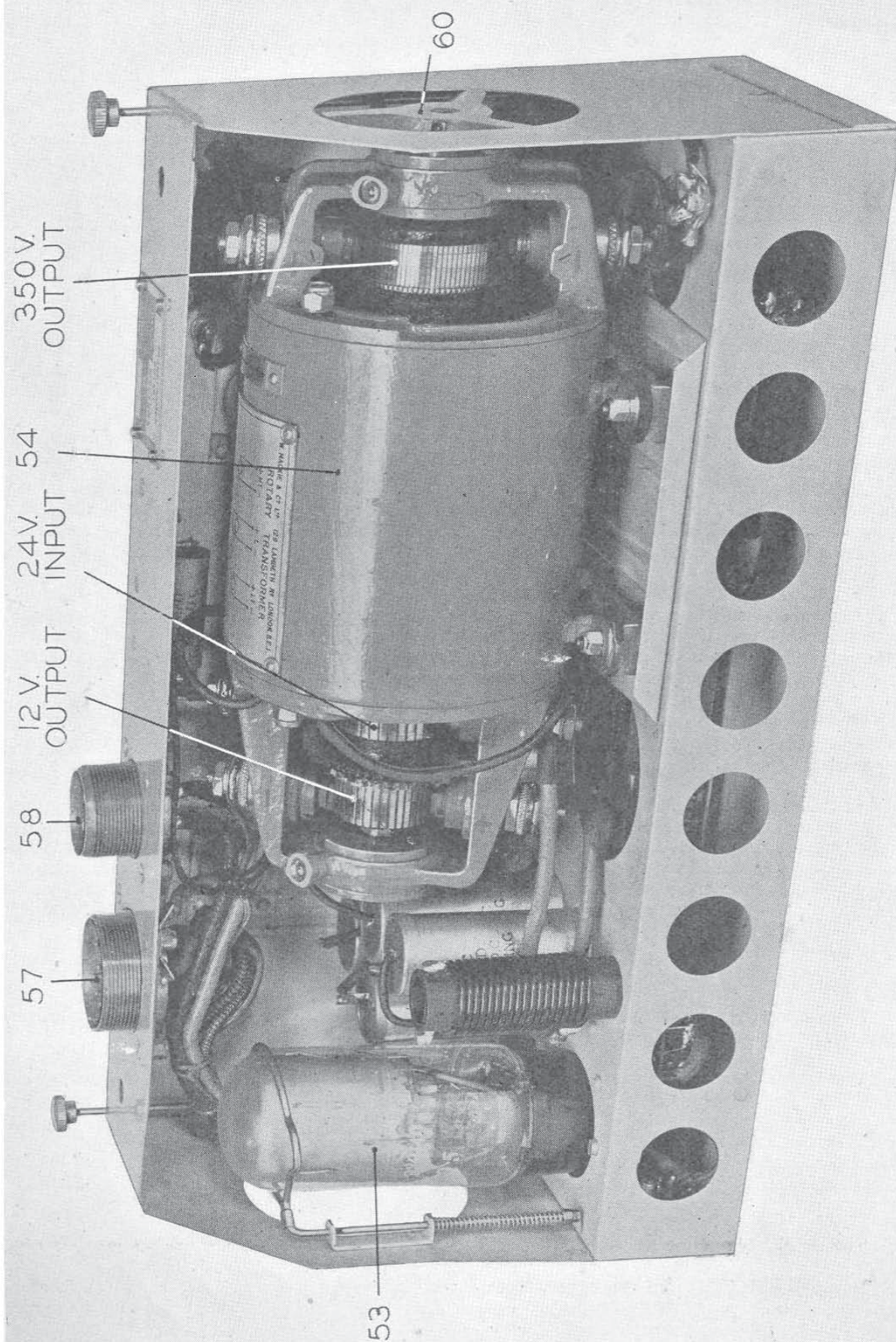
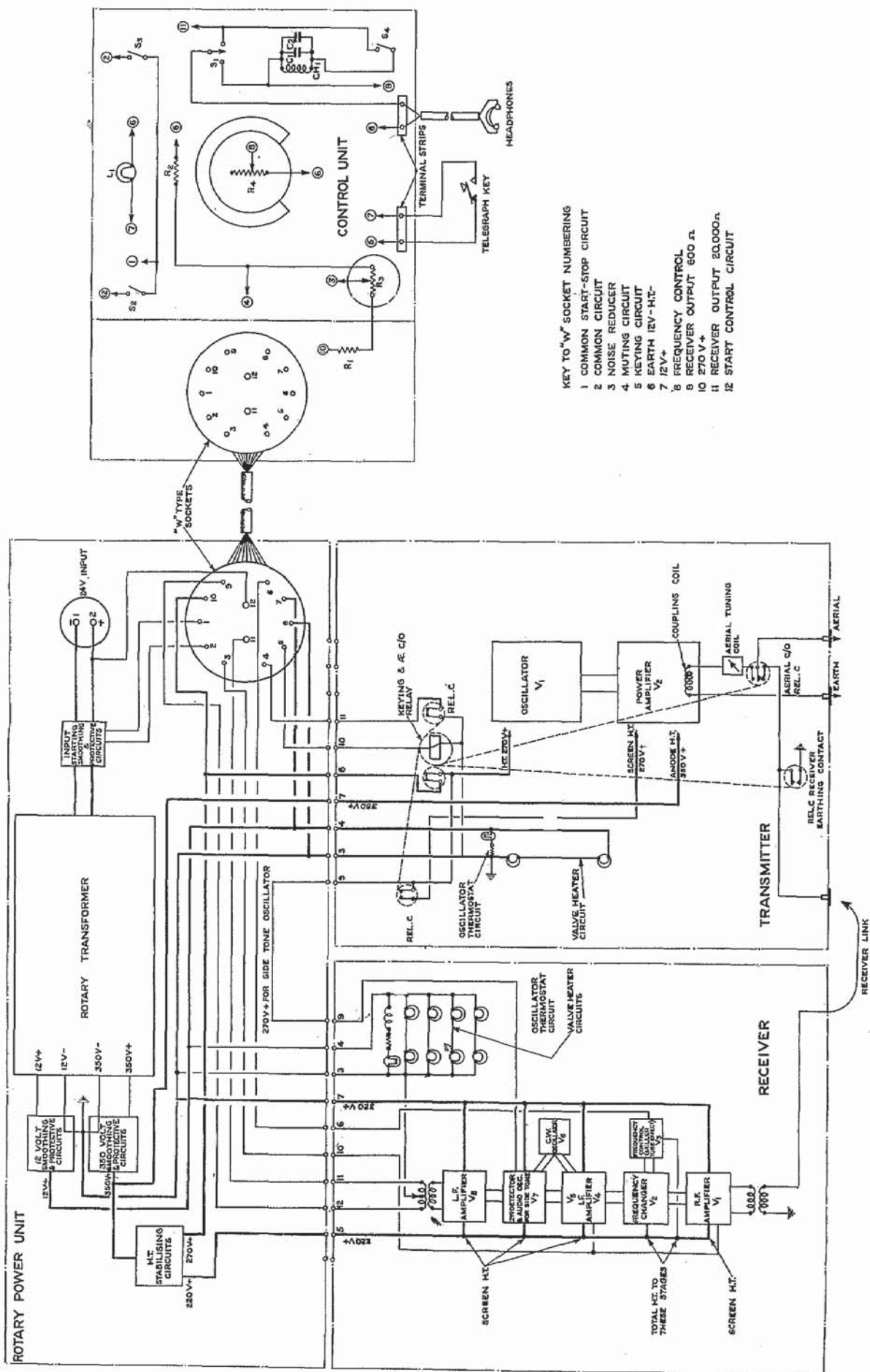


FIG. 10. VIEW OF POWER SUPPLY UNIT



SIMPLIFIED SCHEMATIC DIAGRAM

FIG. 11

OPERATION

General

60. The controls on the T.R.1161 are as follows:—

Transmitter	Oscillator tuning Aerial tuning Oscillator stage trimmers Harmonic generator stage trimmer
Receiver	Oscillator tuning H.F. tuning Aerial trimmer Side-tone volume Low-frequency volume
Control unit	Noise adjusting control Fine control of frequency for receiver Note filter On-off switches

61. A preliminary check should be made of the equipment by removing the units from their cases and seeing that the valves are in their correct positions and properly secured by their retaining clips. The transmitter and receiver are removed by undoing the Dzus fastener at the back of the case above the Jones plug.

62. A check should be made that the Stabivolt stabilising valve is in position in the transformer unit, and also that the lamp is in its holder behind the indicating window in the control unit. It is essential to ensure that the 200-ohm or 7,000-ohm strap is correctly connected in the control unit according to the type of phones used. Access is obtained to the strap by removing the back of the case.

Connecting up

63. Assembly of the units on the main tray should be carried out as follows:—

- (i) Slide the rotary transformer into position, first having lifted the knurled knobs at each end. When the unit is in position, give the knobs a turn and do up the two Dzus fasteners which hold the unit on the tray.
- (ii) Slide the transmitter into position on the right-hand side of the tray and secure in place by the two knurled knobs (16, fig. 6) over the handle (22) on the front.
- (iii) Slide the receiver into position on the left-hand side and secure as with the transmitter.
- (iv) Fix the control unit to the side of the receiver or at a remote point according to the installation.
- (v) Fit the two interconnecting cables, the larger (10), from the rotary unit to the control unit and the smaller (11), from the rotary unit to the battery.
- (vi) Connect the aerial, earth and receiver link (28).

Adjustment of L.F. and side tone control

64. The L.F. and side tone controls should be set to give a convenient output in the following manner. Place the receiver, without the case, into position on the power unit. Start up the aeroplane engine. Switch on, using the ON switch on the control unit. Tune in to a convenient signal. Set the noise reducer to maximum, i.e. fully clockwise. Adjust L.F. VOLUME to a convenient level (this should be done with the phones over the ears to simulate operating conditions). Depress the transmitting key and adjust SIDE TONE VOLUME control to give a convenient level.

65. With the key up, switch on, set the noise adjuster to maximum, set the H.F. and oscillator dials to the same frequency anywhere in the band (preferably at H.F. end). Trim the A.E. trimmers, using tool supplied, for maximum noise.

Tuning the transmitter

66. The equipment is switched on by pressing the RADIO ON button on the control unit. The rotary transformer will start up, the indicator lamp (31) on the control unit will light up and the aerial neon indicator (N1) will strike with a faint glow. Allow half-a-minute for the equipment to warm up.

67. Turn the oscillator tuning knob (17) and the aerial tuning knob (18) to the required frequency. Press the telegraph key, when the neon indicator will glow more brightly indicating that R.F. power is being radiated. If an R.F. ammeter be inserted in the aerial circuit, the current indicated should be 0.7 to 1.1 amps.; this will vary slightly with frequency and aerial capacitance.

68. When the equipment is being worked into a non-standard aerial, the method of lining up is as follows. Switch on the equipment and allow it to warm up for at least half-a-minute, when a faint glow will be observed in the neon indicator. Set the oscillator knob to the desired frequency. Press the key down and tune the aerial tuning knob for maximum glow or, if an aerial ammeter is inserted, for maximum current. The amount of current will vary according to frequency and aerial characteristics.

Tuning the receiver

69. In tuning the receiver, the following operations should be carried out. Referring to fig. 6, the note filter (S4) is switched to OFF, the frequency control (R4) on the control unit set to 0 degrees and the noise adjuster (R3) to maximum, i.e. fully clockwise. The equipment is then switched on with the key up. Oscillator tuning (35) and H.F. tuning (36) are set to the frequency required as marked on the dials. If an interfering signal is experienced, the note filter should be switched in and the frequency control on the control unit adjusted. The maximum output of the side tone is too great for one pair of phones and the side tone volume control should be adjusted accordingly.

70. The audio-frequency output due to the signal is also too great for normal use and this control should be adjusted so that the level is above ordinary cabin noise. It is important to note that when a good signal-to-noise ratio exists, and the output under such conditions is too great, the L.F. volume control must be turned back, and not the noise reducer control. The setting of the noise reducer will give the best operating compromise between high noise level during deep fading and a steady output from the receiver. If the control is turned back, the peak value of noise and signal will be reduced at the expense of greater fluctuations in output level consequent upon fading; in brief, the automatic gain control action will not be so good. The foregoing remarks are of importance, for with the noise reducer set at a maximum there is little audible difference between signals of some 1 to 2 μ V. to values some half-a-million times as great.

71. The note filter will be of use in eliminating beat notes that would normally pass through the audio-amplifier and produce interference. Some reduction in audio level will be experienced, but by a small movement of the frequency control, the desired signal may be peaked at the resonant frequency of the note filter and thus give greater output than the interfering signal. When "listening out", the note filter must be switched out of circuit and used only when interference is experienced.

72. The peak response of the filter is arranged to coincide with the resonant frequency of the telephones and thus the aerial loss with filter in is less than that measured with the telephones out of circuit.

73. The frequency control should always be set to 0 degrees upon setting the receiver up to any required frequency, thus ensuring that the desired signal is within the range of the electrical control provided. The control knob is engraved "Tune to right-hand of zero beat". The reason is that on initial receiver alignment the beat note is arranged to give slightly greater output on the high frequency or INCREASE side on the control dial. The difference will not be noticeable except in the case of a very weak signal.

Separating units

74. To separate the equipment into its various units it is necessary to follow a certain sequence of operations which is detailed below.

- (i) Extract plugs from items (19), (20) and (21) fig. 6 from the front panel of transmitter. Item (19) will remain attached to receiver panel by a short length of connector.
- (ii) Align knobs (18) on transmitter and (35) on receiver in a vertical position.
- (iii) Unscrew the four knurled knobs (16) to maximum extent (these will then swing down below the level of the mounting tray surface) and release withdrawing handles on transmitter (22) and receiver (39).
- (iv) Grip appropriate handle and pull steadily with a slight sideways shake.
- (v) Detach control (10) and battery cables (11) by unscrewing wide knurled collar.
- (vi) Twist two wing-type Dzus catches (13) through 90° counter-clockwise and lift up hinge plates.

- (vii) Lift two plunger type catches (12) and turn through 90° when they will remain in the up position, releasing plungers which project from the base of the power supply unit into holes in the mounting tray. The power unit can now be slid forward like a drawer, using the finger plates (37), in the front panel.

75. It is most important that the power unit should not be withdrawn with the power cable in position owing to the danger from high voltage contacts and the rotating fan. (60, fig. 10).

76. The control unit is detached from its back plate by unscrewing the four large screw heads in the corners of the front panel. These screws cannot be entirely removed.

77. The final operation is the removal of the box covers (3) and (4) from the transmitter and receiver. At the rear of the two boxes is a slotted Dzus fastener head which should be rotated through 90° counter-clockwise. This will release the box cover from the chassis which can now be extracted.

Transmitter adjustment

78. Maintenance will have to be carried out from time to time on the transmitter, such as the replacement of the thermal control relay, valves and neon lamp, and the cleaning of the roller taps on the coils. These matters are dealt with below.

79. The coils are respectively the amplifier, the harmonic generator or doubler, the oscillator and the aerial coil. The first three are screened by rectangular cans.

80. From these cans the following leads project; one from the amplifier can to the anode cap of the first valve and one to the aerial terminal immediately above the back of the neon indicator lamp in the front panel, from which it can be released by the terminal screw; from the harmonic generator can to the anode of the second valve. There are no leads from the oscillator.

81. On the right-hand face of each of the three cans there are holes through which the trimmer condensers can be adjusted by means of the special tools provided.

82. The coil cans are removed in the following manner:—

- (i) Unfasten hook on valve retaining flap.
- (ii) Unscrew two countersunk screws on top of coil cans.
- (iii) Unscrew single countersunk screw in lug at base of coil can on right-hand side.
- (iv) Remove lid of amplifier coil can.
- (v) Slide coil screen up over coil, feeding projecting leads back through the holes.

83. The setting of the tapping rollers on the coils must on no account be disturbed.

84. The valves are removed by unhooking the spring-loaded hook from the valve retaining flap on the side of the can, when the valve can be withdrawn. This retaining flap is adjustable in the event of an oversize valve being supplied.

85. To remove the thermal control relay, it is necessary to locate the relay in the oscillator coil mounted on its panel on one of the corner supporting pillars. The screws holding the panel must be removed and the panel withdrawn gently to the limit of the connecting wires. The glass tube containing the relay is slipped out of the spring clip and its connections unsoldered from the tags on the panel.

86. It is important not to displace the roller contact from the preselected position on the coil. Cleaning, therefore, must be done with carbon tetrachloride applied with a camel-hair brush.

87. The neon indicator lamp is removed by unscrewing the knurled moulded lamp cover and releasing the lamp by pushing in and giving a half-turn.

Receiver adjustment

88. Maintenance to the receiver will include replacement of valves, and the thermal control relay mounted in the H.F. oscillator coil, and cleaning of the contacts.

89. The VR.91 valves are held in their holders by a spring steel clip and it is essential that both prongs on the clip be depressed simultaneously. A special tool is provided for this operation. Valve V_2 is released by depressing the top cap of the valve screen against a spring contained in the cap and then rotating the latter until the arms on the side of the cap clear the straps mounted on the adjacent coil cans. V_5 and V_7 are removed by first removing the grid clip connection and then unscrewing the upper portion of the valve can.

90. To remove the front panel and mask assembly and obtain access to the scale mechanism the following parts have to be disassembled in the sequence given:—

- (i) H.F. tuning knob,
- (ii) oscillator tuning knob,
- (iii) vernier scale pointer disc,
- (iv) aerial lead from block at rear of front panel,
- (v) withdrawing handle securing nuts,
- (vi) two 4 B.A. round-headed screws towards top of front panel.

91. Before replacing the front panel fixing screws check that there is a $\frac{1}{32}$ in. gap between the underside of the chassis and the inside of the lip at the bottom of the front mask in order to ensure that the flange of the receiver case will correctly engage the tip of the front panel. Check that the knob fixing screws engage the holes in the spindles and that the vernier disc slot engages pin in oscillator coil spindle.

92. When removing the H.F. oscillator coil to replace the thermal control relay, or clean the contacts, it is important to note that this assembly has been carefully adjusted for temperature regulation and scale calibration and adjustment must be strictly limited to the above. The front panel and mask must first be removed. Next remove the five external connections to the coil which are connected to tags at the rear end. Remove the four fixing screws securing the coil box to the chassis. The box may be opened by removing the five countersunk screws in the lid.

93. To remove the thermostat, unsolder its connections at the adjacent tags, slacken off the four supporting bracket screws in the side of the can and slide the brackets outwards, thus releasing the thermostat from its fixings. The contact carriage should not be further dismantled or the correct contact pressures will be spoilt. A small amount of light non-freeze oil may be placed on the rear shaft and slip ring contacts but not on the moving carriage contact arm guide rails and operating wheels, or noisy operation will result.

94. When replacing the H.F. oscillator coil, reassemble the thermostat, taking care to assemble the felt washers between the ends of the thermostat and the supporting brackets. Then rotate the thermostat so that the flat surfaces of the springs point towards the centre line of the coil former. Slide the supporting brackets inwards to grip lightly the ends of the thermostat and tighten the fixing screws. Reconnect the thermostat and replace lid of box, then replace and fasten the coil on the chassis. The coil screws should be slipped down to the bottom of the slots, i.e. so that the gear wheels are out of mesh, and lightly secured in this position. The external connections are now replaced.

95. In order that the calibrated scale may be set in the correct relation to the sliding contact of the oscillator coil, it is essential that the two gears are correctly meshed in the following manner:—

- (i) Rotate the oscillator coil spindle fully counter-clockwise.
- (ii) Slack off the coil fixing screws and slide the coil upwards so that the gears mesh together in such a way that the marked tooth on the small gear wheel meshes between the two marked teeth on the large wheel. (This should ensure that in this fully counter-clockwise position of the oscillator coil spindle, the end mark of the outer spiral of the scale lines up with the scale pointer);
- (iii) the depth of meshing of the gears should be adjusted so that there is always slight backlash, but this should not exceed 0.020 in. at the tips of the teeth;
- (iv) tension the backlash spring by moving the free half of the gear towards the coil, rotating it counter-clockwise by ten teeth and allowing it to come forward again into mesh with the large wheel.

PRECAUTIONS AND MAINTENANCE

96. The aerial tuning and oscillator knobs of the receiver and transmitter units of the T.R.1161 equipment are of a special type. They are so designed that if undue force is used when the coils have reached their stop positions, the knob disengages and will not drive the shaft. This condition occurs when the scroll dials are at the extreme centre position or the extreme outer position as indicated by the pointers. If forced, the knobs will slip suddenly and rotate with a clicking noise but if the direction of rotation is reversed the knob will engage again.

97. To remove these knobs, it is necessary to rotate the knob until a small hole behind the handle is visible. There are two "click" positions only, and in one of these the slot of a grub screw is visible down the hole. If this screw is released the knob can be removed from the shaft but this should only be done if the knob is broken or damaged and fails to drive the dials and coils, or if access to the receiver oscillator coil is required.

Power unit adjustments

98. The parts of the power unit which may need attention are; the carbon brushes and commutators of the rotary transformer, replacement of the neon voltage stabiliser, relay contacts and inspection of the plug-in sockets.

99. The rotary transformer is mounted on a separate plate which is held by two hexagon slotted screws just above the coil of the overload relay and also two countersunk screws on the front panel of the unit. If these screws are removed and the connections to the brushes are released, the transformer can be withdrawn.

100. The brushes are removed by unscrewing the knurled terminal caps. When replacing the brushes it is important that they should be returned to their holders in the same position in every way. The commutators should be cleaned with carbon tetrachloride.

101. The voltage stabiliser can be removed by lifting the retaining ring and, when clear of the glass envelope, swinging it to the left.

102. The relay contacts should be cleaned only by competent personnel as relay adjustment is specialised work.

Periodic inspection

103. Periodic inspection of the T.R.1161 equipment is desirable in order to ensure reliable and consistent operation. Below is given a schedule of periodic inspection and tests which should be carried out.

104. *Daily.*—

- (i) Check fully the operation of the transmitter into an artificial load of 10 ohms and 100 μ F.
- (ii) Check connections to the aerial system and the aerial insulators for security.
- (iii) Check telegraph key and headphone connections.

Receiver operation should be checked in the following manner:—

- (i) Rotate noise adjuster on the control unit fully clockwise and check that receiver noise can be heard and that this noise varies with variation in position of the control.
- (ii) Remove receiver aerial plug from transmitter socket and check that the receiver noise decreases.
- (iii) Press telegraph key and check that side-tone note can be heard.
- (iv) Set both dials on receiver to 3.3 Mc/s. Then rotate receiver tuning knob on control unit and check that pitch of note heard varies as this control is rotated in either direction.

105. *After 10 hours flying time.*—

- (i) Check engagement of all plugs and sockets.
- (ii) Remove all units from the tray according to the instructions already given (para. 74) and inspect for loose components, connections, nuts, screws, etc.
- (iii) Inspect power supply unit. Clean commutators with carbon tetrachloride and, if pitted, with fine glass paper; emery cloth must not on any account be used. Check that brushes are bedding down properly and that all connections are secure. Remove any dust.
- (iv) Ensure that the valves of all units are fully engaged in their sockets and that the retaining clips and anode and grip caps are in position.
- (v) Check all shock absorbers for wear.
- (vi) Examine aerial wire for frayed strands and bonding of cables.

106. *After 30 hours flying time.*—

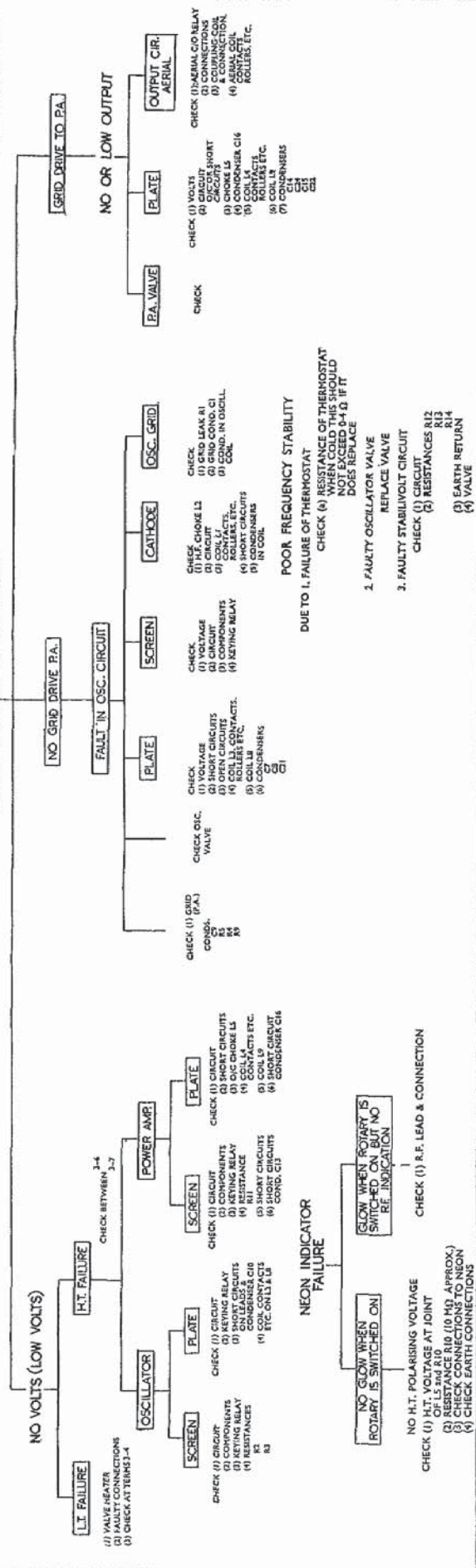
- (i) Inspect the two socket panels on the power supply unit and ensure that the spring contact is not misplaced.
- (ii) Check the grid drive to the power amplifier and also the power output.

107. The grid drive should be greater than 1.6 mA and the aerial current should be 0.7 to 1.1 amp. into an artificial aerial of 10 ohms and 100 μ F. If these figures are not obtained, check the battery voltage.

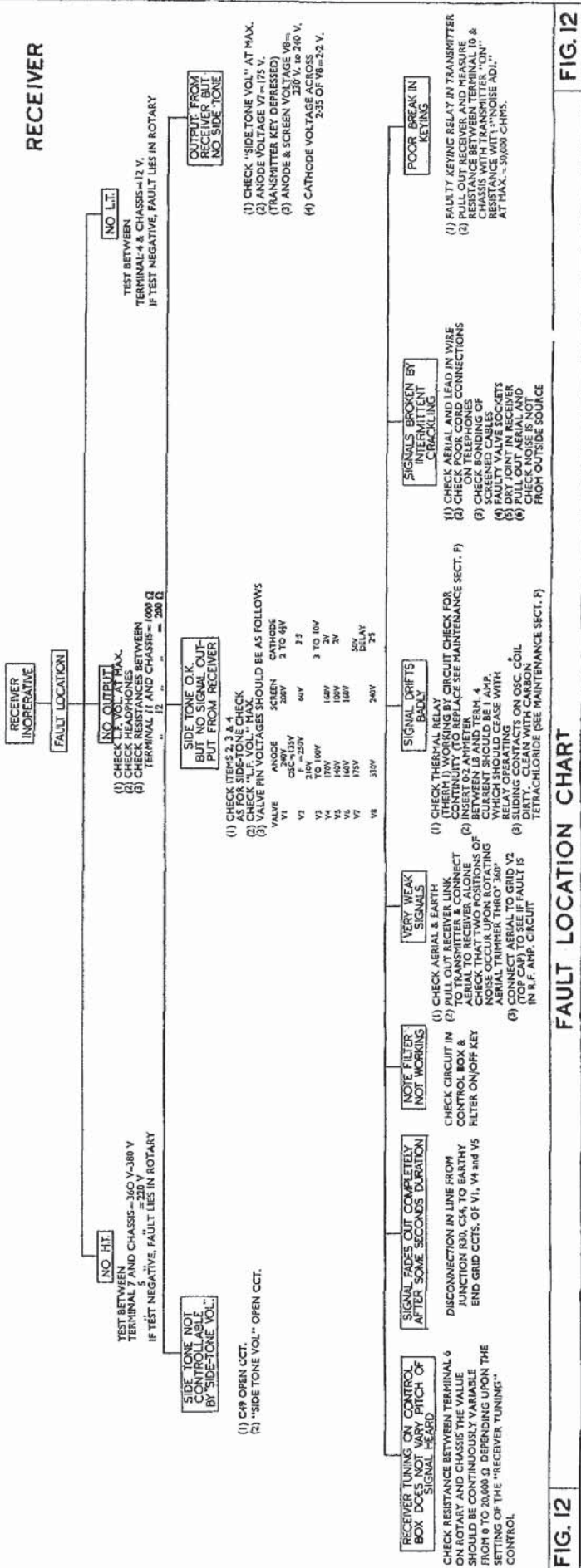
Fault location

108. Three charts are given in figs. 12 and 13 for the purpose of fault location. One of these is for the transmitter, another for the receiver and the third for the power supply. They are in the form of genealogical trees, the various symptoms of failure being shown at the top; the method of tracing through is to follow the various branches according to the nature of the trouble. These charts cannot take the place of systematic tests with the use of suitable apparatus but they will assist in locating a fault to a particular circuit or component, and should suffice to trace most of the troubles that are likely to develop.

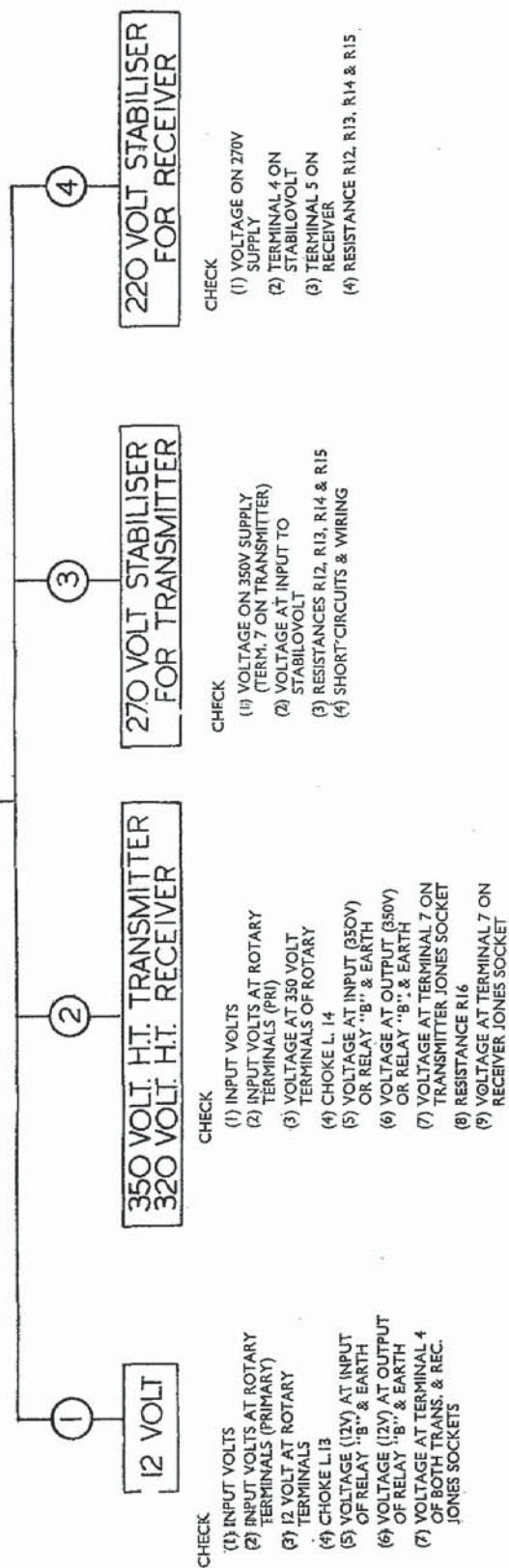
NO POWER OUTPUT OR LOW OUTPUT



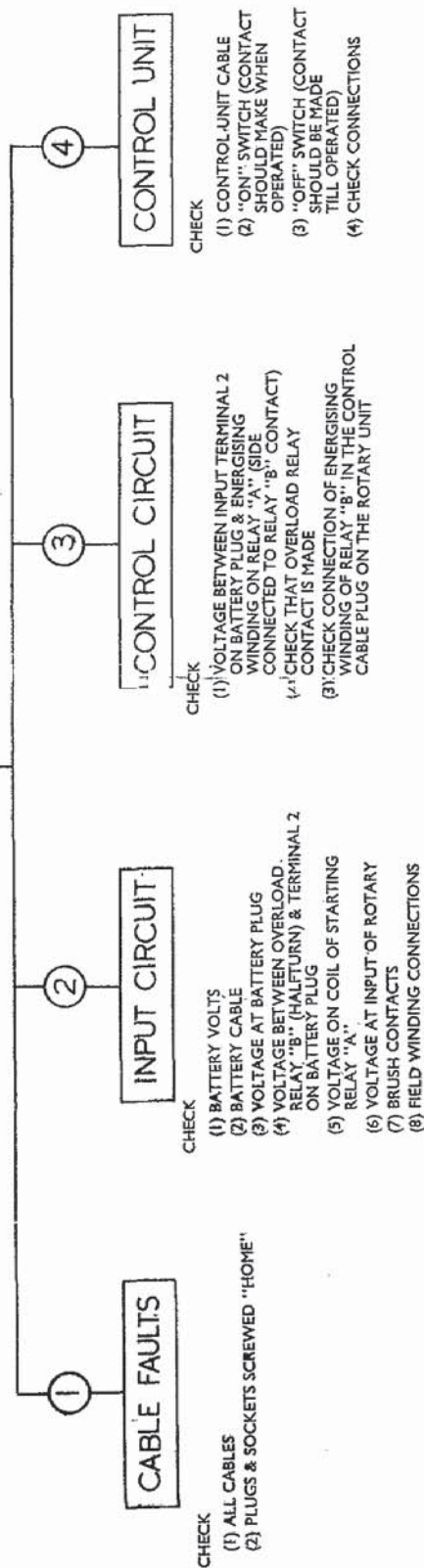
RECEIVER



NO OR LOW VOLTAGE OUTPUT



FAILURE TO START



FAULT LOCATION CHART-POWER SUPPLY CIRCUIT

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.		Remarks
10D/256	Transmitter-receiver T.R.1161	1		
	Consisting of:—			
10L/31	Control unit	1		
10K/69	Power unit	1		
10P/1	Receiver	1		
10R/2	Transmitter	1		
	Cables	2		
	Control unit		Ref. in fig. 4	
	Principal components:—			
	Choke			
10C/3258	Type 230	1	Ch.1	
	Condenser			
10C/4428	Type 2294	1	C ₁	0.15 μ F.
10C/4429	Type 2295	1	C ₂	0.015 μ F.
10C/	Lamp			
	Type	1	L ₁	12 V. 3 watt
	Resistance			
10C/1592	Type 1592	1	R ₁	150,000 ohms, $\frac{1}{2}$ W.
10C/27	Type 544	1	R ₂	10,000 ohms, $\frac{1}{2}$ W.
10C/1973	Type 1973	1	R ₃	2,000 ohms, pot.
10C/1800	Type 1800	1	R ₄	20,000 ohms, pot.
	Switch			
	Type	1	S ₁	
	Type	1	S ₂	Normally "off"
	Type	1	S ₃	Normally "on"
10F/662	Type 525	1	S ₄	On-off
	Power unit		Ref. in fig. 5	
	Principal components:—			
	Choke			
10C/3009	Type 139	2	L ₁₁ , L ₁₂	
10C/3013	Type 141	1	L ₁₃	
10C/2999	Type 140	1	L ₁₄	
	Condenser			
10C/3324	Type 1630	4	C ₂₉ , C ₃₀ , C ₃₁ , C ₃₂	2 μ F. 50 V. D.C.
10C/3086	Type 1492	1	C ₃₃	0.1 μ F. 350 V. wkg.
10C/3324	Type 1630	1	C ₃₄	2 μ F. 50 V. D.C.
10C/10391	Type 401	1	C ₃₅	0.002 μ F. 2,200 V. test
10C/3091	Type 1497	1	C ₃₆	25 μ F. electrolytic 500 V wkg.
	Relay			
10F/534	Type 230	1	REL. A	Starter
10F/533	Type 299	1	REL. B	Overload
	Resistance			
10C/11093	Type 466	3	R ₁₂ , R ₁₃ , R ₁₄	1 megohm, $\frac{1}{2}$ W.
	Type	1	R ₁₅	1,000 ohms
10C/2984	Type 111	1	R ₁₆	(2–2,000 ohms in par.) 2,000 ohms (2 to 1,000 ohms in series)
	Valve			
10E/11449	Type VS.68	1	St. VI	Stabilovolt
	Receiver		Ref. in fig. 3	
	Principal components			
	Condenser			
10C/3085	Type 1491	1	C ₁ , C ₂	2-gang
10C/3084	Type 1490	1	C ₃	3 to 25 μ F. ceramic
	Type	1	C ₄	12 to 42 μ F. ceramic
10C/3087	Type 1493	8	C ₅ , C ₆ , C ₇ , C ₈ , C ₉ , C ₁₀ , C ₁₁ , C ₁₂	0.1 μ F

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receiver (contd.)			
	Principal components (contd.)			
	Condenser (contd.)			
10C/3299	Type 1608	1	C ₁₄	3.5 to 25 μ F.
	Type	1	C ₁₅	0.00025 μ F.
10C/11485	Type 536	1	C ₁₆	50 μ F.
	Type	2	C _{17a} , C _{17b}	500 μ F.
				440 μ F.
10C/11485	Type 536	1	C ₂₀	50 μ F. mica
10C/3087	Type 1493	3	C ₂₁ , C ₂₂ , C ₂₃	0.1 μ F. 350 V. wkg.
	Type	1	C ₂₄	115 μ F. $\pm$ 1 per cent.
	Type	2	C ₂₅ , C ₂₆	12-42 μ F.
	Type	1	C ₂₇	115 μ F.
	Type	1	C ₂₈	0.0005 μ F.
10C/3087	Type 1493	3	C ₂₉ , C ₃₀ , C ₃₁	0.1 μ F.
	Type	1	C ₃₂	115 μ F.
	Type	2	C ₃₃ , C ₃₄	12 to 42 μ F.
	Type	1	C ₃₅	115 μ F. $\pm$ 1 per cent.
10C/3087	Type 1493	3	C ₃₆ , C ₃₇ , C ₃₈	0.1 μ F.
	Type	1	C ₃₉	115 μ F. $\pm$ 1 per cent.
	Type	2	C ₄₀ , C ₄₁	12 to 42 μ F.
10C/11485	Type 536	1	C ₄₂	50 μ F.
10C/3927	Type 1996	1	C ₄₃	20 μ F.
10C/3087	Type 1493	1	C ₄₅	0.1 μ F.
10C/8388	Type 178	1	C ₄₆	0.0002 μ F.
10C/7902	Type 121	1	C ₄₇	0.0001 μ F.
10C/3087	Type 1493	1	C ₄₈	0.1 μ F.
10C/3317	Type 1623	1	C ₄₉	8 μ F.
10C/3087	Type 1493	1	C ₅₀	0.1 μ F.
10C/4428	Type 2294	1	C ₅₁	0.15 μ F. $\pm$ 1 per cent.
10C/3316	Type 1622	1	C ₅₂	0.05 μ F.
10C/7901	Type 120	1	C ₅₃	0.001 μ F.
10C/3087	Type 1493	1	C ₅₄	0.1 μ F.
10C/3318	Type 1624	1	C ₅₅	25 μ F. electrolytic
				12 V.
10C/3087	Type 1493	2	C ₅₆ , C ₅₇	0.1 μ F.
	Type	1	C ₆₀	320 μ F. $\pm$ 2 per cent.
	Type	1	C _{61a}	100 μ F. $\pm$ 2 per cent.
	Type	1	C _{61b}	80 μ F. $\pm$ 2 per cent.
	Type	1	C _{61c}	40 μ F. $\pm$ 2 per cent.
	Type	1	C _{61d}	20 μ F. $\pm$ 2 per cent.
	Type	1	C _{62a}	100 μ F. $\pm$ 2 per cent.
	Type	1	C _{62b}	80 μ F. $\pm$ 2 per cent.
	Type	1	C _{62c}	40 μ F. $\pm$ 2 per cent.
	Type	1	C _{62d}	20 μ F. $\pm$ 2 per cent.
10C/3087	Type 1493	1	C ₆₃	0.1 μ F. 350 V. wkg.
10C/4429	Type 2295	2	C ₆₄ , C ₆₅	0.02 μ F. 450 V. wkg.
		1	C ₆₆	0.015 μ F.
	Inductance			
	Type	1	L ₁	
	Type	1	L ₂	
	Type	1	L ₃	
	Type	1	L ₄	
	Type	1	L ₅	
	Type	1	L ₆	
	Type	1	L ₇	
	Type	1	L ₈	
	Relay			
	Type	1	THERM. 1	Thermostat
	Resistance			
10C/1562	Type 1562	1	R ₁	100,000 ohms, $\frac{1}{2}$ W.
10C/1619	Type 1619	1	R ₂	300 ohms, $\frac{1}{2}$ W.
10C/11678	Type 512	1	R ₃	1,000 ohms, $\frac{1}{2}$ W.
10C/11683	Type 517	1	R ₄	15,000 ohms, $\frac{1}{2}$ W.
10C/7829	Type 7829	1	R ₅	50,000 ohms, $\frac{1}{2}$ W.
10C/953	Type 561	1	R ₆	100 ohms, $\frac{1}{2}$ W.
10C/6185	Type 6185	1	R ₇	50,000 ohms, $\frac{1}{2}$ W.
10C/1865	Type 1865	1	R ₈	500 ohms, $\frac{1}{2}$ W.
10C/6183	Type 6183	1	R ₁₀	5,000 ohms, $\frac{1}{2}$ W.
10C/1971	Type 1971	1	R ₁₁	15,000 ohms $\pm$ 5 per cent.
				7 W.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
Receiver (contd.)				
Principal components (contd.)				
Resistance (contd.)				
10C/953	Type 561	1	R ₁₂	100 ohms, $\frac{1}{2}$ W.
10C/1972	Type 1972	1	R ₁₃	25,000 ohms $\pm$ 5 per cent. 7 W.
10C/7829	Type 7829	1	R ₁₄	50,000 ohms, $\frac{1}{2}$ W.
10C/1562	Type 1562	1	R ₁₅	100,000 ohms, $\frac{1}{2}$ W.
10C/1865	Type 1865	1	R ₁₆	500 ohms, $\frac{1}{2}$ W.
10C/6185	Type 6185	2	R ₁₇ , R ₁₈	50,000 ohms, $\frac{1}{2}$ W.
10C/1562	Type 1562	1	R ₁₉	100,000 ohms, $\frac{1}{2}$ W.
10C/1865	Type 1865	1	R ₂₀	500 ohms, $\frac{1}{2}$ W.
10C/6115	Type 6115	1	R ₂₁	100,000 ohms, $\frac{1}{2}$ W.
10C/7829	Type 7829	1	R ₂₂	50,000 ohms, $\frac{1}{2}$ W.
10C/1756	Type 1756	1	R ₂₃	25,000 ohms, $\frac{1}{2}$ W.
10C/1116	Type 1116	1	R ₂₄	$\frac{1}{2}$ megohm, $\frac{1}{2}$ W.
10C/6185	Type 6185	1	R ₂₅	50,000 ohms, $\frac{1}{2}$ W.
		1	R ₂₆	220,000 ohms, $\frac{1}{2}$ W.
10C/1015	Type 1015	1	R ₂₇	10,000 ohms, $\frac{1}{2}$ W.
10C/10140	Type 368	1	R ₂₈	30,000 ohms, $\frac{1}{2}$ W.
10C/7820	Type 7829	1	R ₂₉	50,000 ohms.
10C/1756	Type 1756	1	R ₃₀	25,000 ohms, $\frac{1}{2}$ W.
10C/1116	Type 1116	1	R ₃₁	$\frac{1}{2}$ megohm, $\frac{1}{2}$ W.
10C/1734	Type 1734	1	R ₃₂	$\frac{1}{2}$ megohm pot.
10C/6185	Type 6185	1	R ₃₃	50,000 ohms, $\frac{1}{2}$ W.
10C/1734	Type 1734	1	R ₃₄	$\frac{1}{2}$ megohm pot.
10C/1619	Type 1619	1	R ₃₅	300 ohms, $\frac{1}{2}$ W.
10C/1015	Type 1015	1	R ₃₆	10,000 ohms, $\frac{1}{2}$ W.
10C/6185	Type 6185	1	R ₃₇	50,000 ohms, $\frac{1}{2}$ W.
	Type	1	R ₃₈	150,000 ohms, $\frac{1}{2}$ W.
	Type	3	R ₃₉ , R ₄₀ , R ₄₁	4 ohms $\pm$ 5 per cent., 5 W.
10C/1619	Type 1619	1	R ₄₂	300 ohms $\pm$ 10 per cent. $\frac{1}{2}$ W.
Transformer				
	Type	1	T ₁	
Valve				
10E/92	Type V.R.91	1	V ₁	
10E/405	Type 6K8G	1	V ₂	
10E/92	Type V.R.91	1	V ₃	
10E/92	Type V.R.91	1	V ₄	
10E/11399	Type V.R.53	1	V ₅	
10E/92	Type V.R.91	1	V ₆	
10E/11401	Type V.R.55	1	V ₇	
10E/92	Type V.R.91	1	V ₈	
Transmitter				
Principal components:—				
Coil				
	Type	1	L ₁	
10C/2054	Type 86	1	L ₂	
	Type	1	L ₃	Harmonic producer
	Type	1	L ₄	Output
	Type	1	L ₅	
	Type	1	L ₆	
	Type	1	L ₇	Aerial loading
	Type	1	L ₈	
	Type	1	L ₉	
Condenser				
	Type	1	C ₁	200 μ F
	Type	2	C ₂ , C ₃	3-20 μ F.
	Type	1	C ₄	1,300 μ F. $\pm$ 1 per cent. 1,000 V. D.C. test
10C/3055	Type 1465	2	C ₅ , C ₆	0.01 μ F.
	Type	1	C ₇	3-20 μ F.
	Type	1	C ₈	135 μ F. $\pm$ 1 per cent.
	Type	1	C ₉	50 μ F. ceramic cap type
10C/3055	Type 1465	2	C ₁₀ , C ₁₃	0.01 μ F.
10C/2835	Type 1394	2	C ₁₁ , C ₁₂	

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10C/3055	Receiver (<i>contd.</i>)			
	Principal components (<i>contd.</i>)			
	Condenser (<i>contd.</i>)			
	Type	1	C ₁₄	3-20 $\mu\mu$ F.
	Type	1	C ₁₅	160 $\mu\mu$ F.
	Type 1465	1	C ₁₆	0.01 μ F.
	Type	1	C ₁₉	1,000 $\mu\mu$ F. $\pm$ 1 per cent.
				1,000 V. D.C. test
	Type	1	C ₂₉	100, 75, 50 and 25 $\mu\mu$ F.
				+315, 100
10E/484	Type	1		100, 75, 50 and 25 $\mu\mu$ F.
				250 $\mu\mu$ F.
	Type	2	C ₂₁ , C ₂₂	1,000 $\mu\mu$ F. $\pm$ 5 per cent.
	Type	1	C ₂₃	100 $\mu\mu$ F. (2)
	Type	1	C ₂₄	3-20 $\mu\mu$ F.
10E/484	Neon lamp			
	Type 15	1	N ₁	Bayonet cap
10F/599	Relay			
	Type	1	T ₁	
10F/599	Type 241	1	REL. C	
10C/1717	Resistance			
	Type 1717	1	R ₁	20,000 ohms, 5 W.
10C/1718	Type 1718	1	R ₂	20,000 ohms, 10 W.
10C/1719	Type 1719	1	R ₃	50,000 ohms, 10 W.
10C/1721	Type 1721	1	R ₄	15,000 ohms, 5 W.
10C/1111	Type 456	1	R ₅	50 ohms, $\frac{1}{2}$ W.
10C/1720	Type 1720	1	R ₆	150 ohms, 5 W.
10C/1111	Type	2	R ₇ , R ₈	9 ohms, 5 W.
	Type 456	1	R ₉	50 ohms, $\frac{1}{2}$ W.
10C/1618	Type 1618	1	R ₁₀	10 megohms, $\frac{1}{2}$ W.
10C/6422	Type 6422	1	R ₁₁	300 ohms, 5 W.
10E/11441	Valve			
	Type V.T.60	2	V ₁ , V ₂	

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SECTION 2, CHAPTER 11

TRANSMITTER-RECEIVER T.R.1304

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**CONCISE DETAILS OF
TRANSMITTER-RECEIVER T.R.1304**

PURPOSE OF EQUIPMENT	R.T. communication on any one of four crystal-controlled frequencies		
TYPE OF WAVE			
FREQUENCY RANGE	Transmitter: 3-10 Mc/s. Receiver 2-12 Mc/s any 1.9 to 1 band		
FREQUENCY STABILITY	Better than 0.004 per cent for L.T. variation of 10 to 14.5 volts and better than ± 180 parts 10^6 between $+ 30^{\circ}$ C. and $- 30^{\circ}$ C.		
CRYSTAL MULT. FACTOR			
PERCENTAGE MODULATION			
MAXIMUM SENSITIVITY	Signal noise ratio greater than 10 db. with 5 μ V. modulated 30 per cent at 1,000 c/s into an aerial of 5 ohms 100 μ F. giving an output of 10 μ W. into 10,000 ohms.		
SELECTIVITY			
OUTPUT IMPEDANCE			
AMPLIFIER CLASS	A-B push-pull		
MICROPHONE TYPE	Electro-magnetic		
VALVES	Transmitter: Crystal oscillator, type 6F6G. R.F. amplifier, type 58/300B. Receiver: R.F. amplifier, type 6U7G. Frequency changer, type 6K8G. 1st I.F. amplifier, type 6U7G. 2nd I.F. amplifier detector and A.V.C. rectifier, type 6B8G. Amplifier: Pentode, type 6U7G, double triode, type 33A/100A, double triode, type 33A/100A		
POWER INPUT	200 watts (max.)		
POWER OUTPUT	3 watts		
STORES REF. No.	10D/611		
APPROXIMATE OVERALL DIMENSIONS	LENGTH 16 $\frac{3}{4}$ in.	WIDTH 14 in.	HEIGHT 9 $\frac{3}{4}$ in.
WEIGHT	50 lb. (exclusive of cables)		
ASSOCIATED EQUIPMENT	Remote control unit Junction box Cables		

SECTION 2

Chapter 11

- (2) Trouble has been experienced resulting in damage to crystals due to over-excitation. The screen potential on the oscillator valve should therefore be reduced. This can be done by changing over the two resistances R_2 and R_3 (fig. 3) so that $R_2 = 40,000$ ohms and $R_3 = 15,000$ ohms. This will not affect the efficiency of the transmitter.
- (3) Filter condensers C_4 , C_5 , C_6 , C_7 and C_8 in the power unit (fig. 2) which were $2 \mu F.$ in later models are $1.5 \mu F.$, 50 volt working.

TRANSMITTER-RECEIVER T.R.1304

(Stores Ref. 10D/611)

INTRODUCTION

1. The T.R.1304 is a transmitter-receiver designed for use in aircraft. The equipment is a self-contained remote-controlled transmitter and receiver and comprises a single main unit, remote-control unit, junction box and interconnecting cables. These units are shown in the general view, fig. 1, which illustrates the main unit shown in the centre, the junction box on the left and the remote control at the right.

2. The main unit comprises the transmitter, receiver, audio unit, rotary transformer, aerial change-over and a multiple junction box to which all interconnecting cables are connected. The unit is provided with a cover and is mounted on a shock absorber. Interconnecting cables are of the Breeze type, fitted with Breeze plugs and sockets.

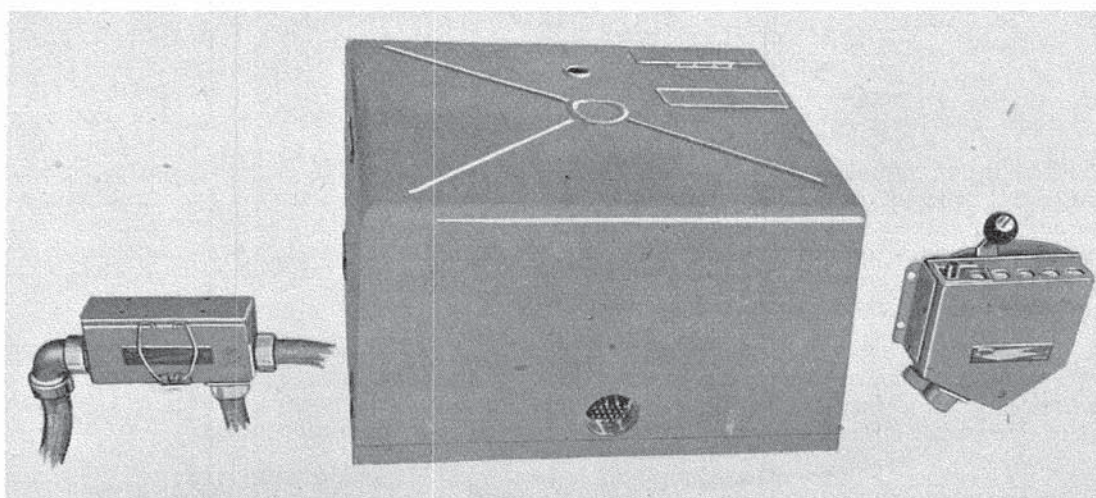


FIG. 1.—TRANSMITTER-RECEIVER T.R.1304

3. The apparatus provides for R/T communication on any one of the crystal controlled frequencies. Those on the transmitter may be located anywhere within the band 3 to 10 Mc/s. The four crystal-controlled frequencies for the receiver cover from 2 to 12 Mc/s., the ratio of the extremes of the band, however, being limited to 1.9 to 1.

4. Frequency selection for both transmitter and receiver is simultaneously controlled by a single lever on the remote control, but this lever may be duplicated in order to provide separate control for each should this be necessary. Signal lights situated in the control box indicate the spot frequency in use and also the position of the send-receive switch.

5. The carrier power available from the transmitter is in excess of three watts (based on a load of $100\ \mu\mu\text{ F}$ and 5 ohms). The receiver has a sensitivity such that an input of 5 microvolts modulated to a depth of 90 per cent will result in more than 200 milliwatts being delivered to the headphone circuit, the volume level of which is variable by preset adjustment.

6. An audio amplifier is provided which serves for modulation of the transmitter and also provides audio amplification for the receiver. An electro-magnetic microphone is employed in order to secure maximum intelligibility.

7. The equipment is designed to operate from a 12- or 24-volt battery. The dimensions of the main unit are approximately $16\frac{3}{4}$ in. by $9\frac{3}{4}$ in. deep and the weight, exclusive of the cables, is 50 lb. Fig. 2 shows the circuit of the complete equipment.

8. In the following description of the equipment the annotational references are from 1 upwards for each unit but in order to simplify identification the figure number to which a reference relates is given where necessary.

GENERAL DESCRIPTION

Transmitter

9. A theoretical circuit diagram of the transmitter is given in fig. 3 and it will be seen that it comprises a two-stage unit consisting of a crystal-controlled master oscillator, V_1 and a R.F. amplifier, V_2 . Valve V_1 in the first stage is a pentode valve with the crystal connected between anode and control grid. Coupling between this valve and the R.F. amplifier valve is by means of the choke L_5 . The R.F. amplifier valve is also a pentode valve and its anode is connected to the output circuit. As will be seen from the diagram, fig. 3, the output circuit consists of a plug-in coil with two continuously variable taps (of the roller type) connected to the anode and aerial.

10. Four crystals are provided for the master oscillator circuits, one for each of the four spot frequencies, and there are four corresponding aerial output circuit coils; any one pair of crystal and coil can be selected by the ganged switch S_1 operated by the step-by-step mechanism, the switch S_{1e} cutting out the unused coils. In order to check the master oscillator drive to the output, a 2-pin. socket is provided wired across R_8 into which a grid meter may be inserted.

Receiver

11. Reference to the circuit diagram of the receiver, fig. 4, will show that it is a four-valve superheterodyne employing the following valves:—

V_1 —R.F. amplifier stage	pentode
V_2 —Frequency changer	heptode
V_3 —1st I.F. amplifier	pentode
V_4 —2nd I.F. amplifier detector and A.V.C. rectifier	double diode pentode

12. The input circuit to the R.F. valve, V_1 , consists of a coil L_1 shunted by the trimmer condensers C_3 , C_4 , C_5 and C_6 , any one of which may be selected by the switch S_{2c} . The anode of this valve is coupled through the H.F. transformer L_2 to the mixer, or frequency changer, valve V_2 . The first and second grids of V_2 function as grid and anode of a triode and an oscillator circuit is formed by connecting across them any one of the four crystals X_1 , X_2 , X_3 or X_4 , the particular crystal required being selected by the switch S_{2a} .

13. Four trimmer condensers C_{10} , C_{11} , C_{12} and C_{13} are placed between the fourth grid and earth of V_2 and any one of these may be selected by the switch S_{2b} . The switches, S_{2a} , S_{2b} , S_{2c} and S_{2d} , for the selection of any one crystal and any one trimmer condenser from each of the two groups are part of one switch assembly which is driven by the step-by-step mechanism.

14. The resultant I.F. from V_2 is amplified in turn by V_3 and the screen portion of V_4 , rectification being carried out by one of the diodes in this valve. The remaining diode functions as an A.V.C. rectifier.

Audio-frequency amplifier

15. The audio-frequency unit, a theoretical circuit diagram of which is shown in fig. 5, employs three valves. V_1 is a pentode valve, V_2 is a double triode and V_3 also is a double triode. During transmission all three valves are employed, but for reception the first two stages only are used. When the transmitter is in operation the output from the microphone, which is balanced about earth, is fed via a shielded cable into the fully shrouded microphone transformer T_1 , the output of which is matched to 250,000 ohms across the grid of V_1 , a pentode valve. The anode of the valve is transformer coupled by the transformer T_2 to the control grids of the double-triode V_2 operating in class A-B push-pull. The grid windings of V_2 are loaded with 50,000 ohms each side and the valve draws no grid current. The anode circuit of V_2 is coupled by a transformer, T_3 , to another double triode V_3 which is the same type as V_2 . The grids of the valve V_3 , are loaded with 5,000 ohms each side and are driven into grid current. Valve V_1 derives its grid bias from the cathode resistance R_9 , but the cathodes of V_2 and V_3 are connected direct to L.T. +. The third valve V_3 , is coupled to the transmitter by the modulation transformer T_4 .

16. The first and second stages of the audio-frequency amplifier also function when the receiver is in operation. The output from V_4 (fig. 3) is taken to a separate winding (terminals 3 and 4) on T_1 (fig. 4) the output to the headphone circuit being taken from a special winding on T_3 (terminals 9 and 10).

17. The output of the side-tone circuit can be varied by changing the value of the side-tone attenuator R_{10} (fig. 5). Experience has shown that the present level of 80 mW. (100 per cent tone modulation) is correct when a normal type of helmet is used in the orthodox type of fighter aircraft.

Power supply unit

18. The theoretical circuit diagram of the power supply unit is given in the complete circuit diagram fig. 2.

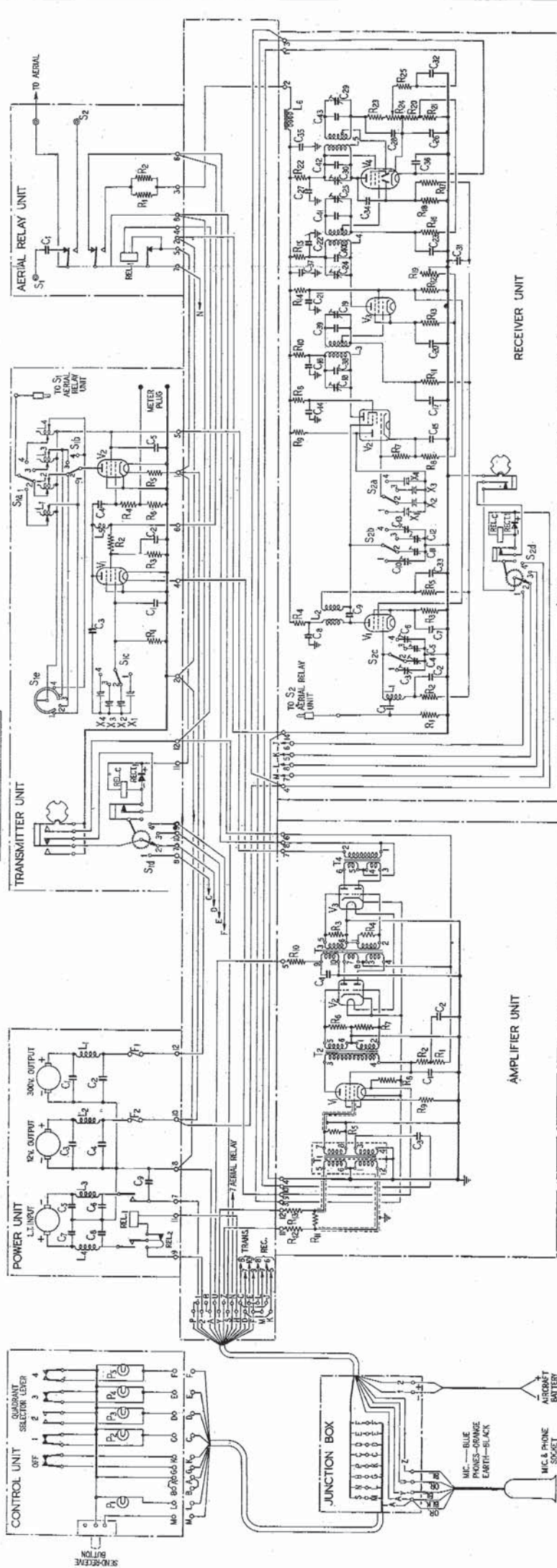


FIG. 2

T.R. 1304, CIRCUIT DIAGRAM

FIG. 2

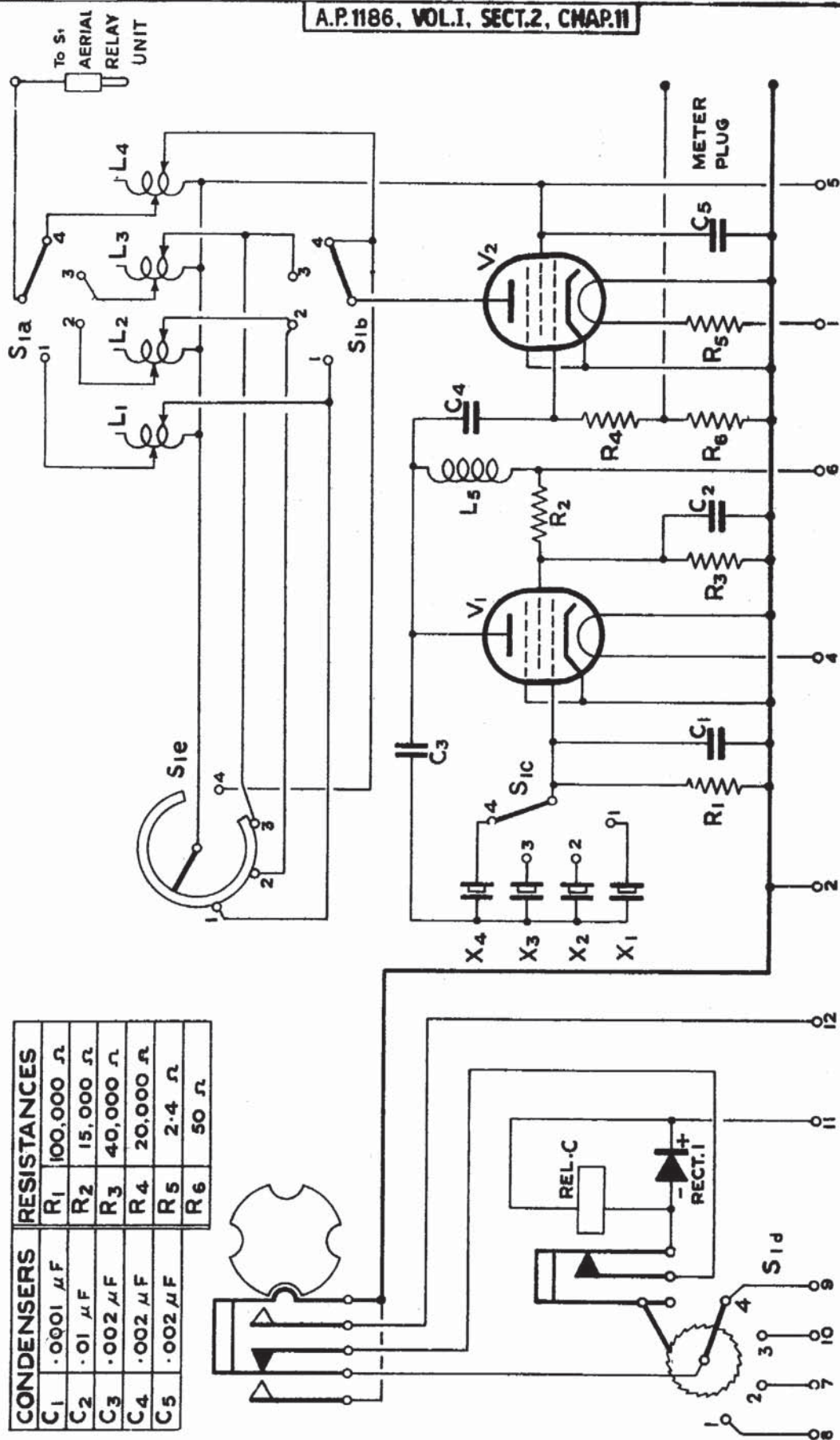
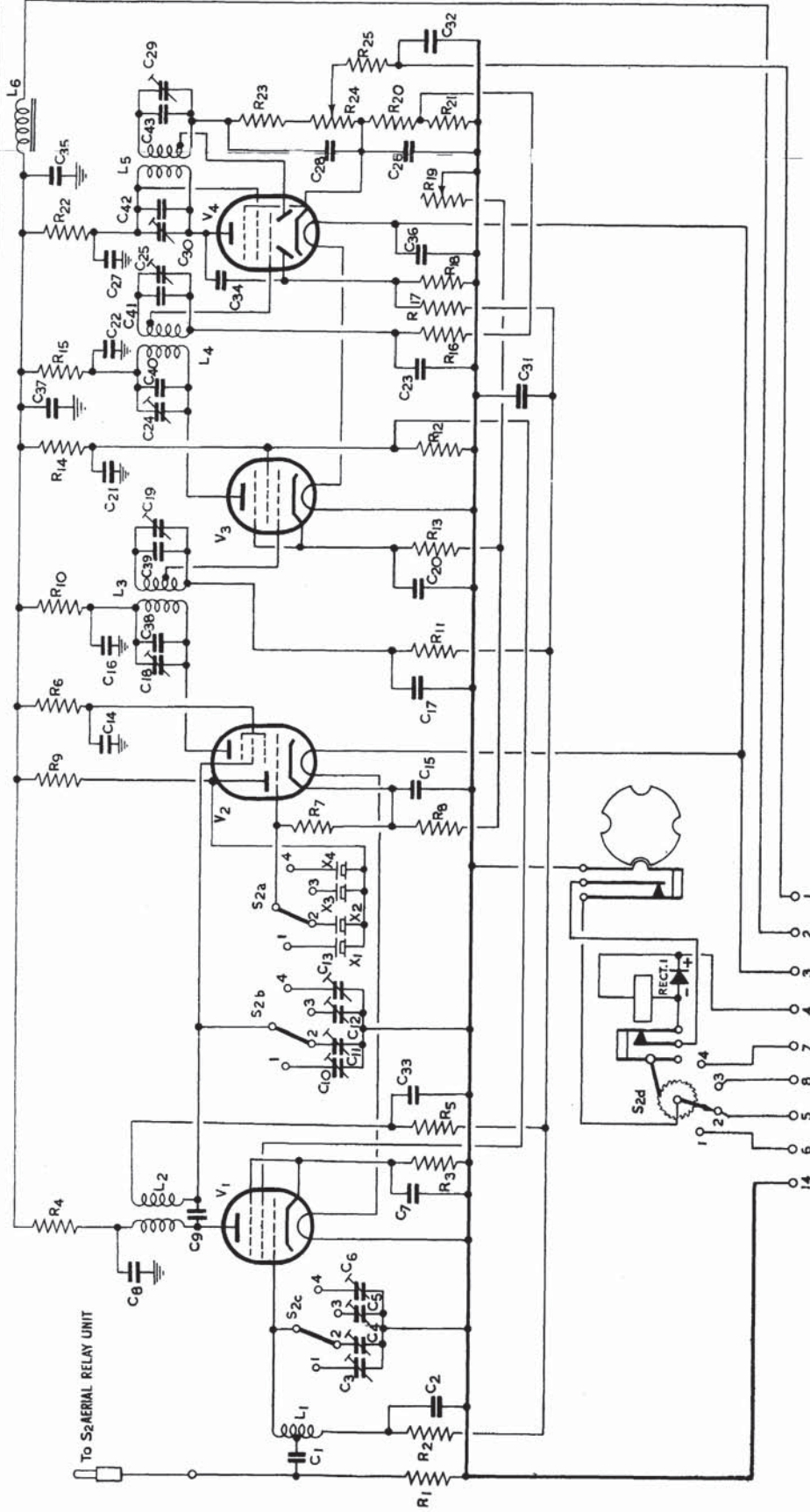


FIG. 3

FIG. 3

TRANSMITTER CIRCUIT DIAGRAM



CONDENSERS			
C1	0.001 μ F	C90	1 μ F
C2	1 μ F	C21	1 μ F
C3	7-110 μ M F	C22	1 μ F
C4	7-110 μ M F	C23	1 μ F
C5	7-110 μ M F	C24	15-45 μ M F
C6	7-110 μ M F	C25	15-45 μ M F
C7	1 μ F	C26	1 μ F
C8	1 μ F	C27	1 μ F
C9	3 μ M F	C28	0.001 μ F
C10	7-110 μ M F	C29	15-45 μ M F
C11	7-110 μ M F	C30	15-45 μ M F
C12	7-110 μ M F	C31	0.1 μ F
C13	7-110 μ M F	C32	0.0005 μ F
C14	1 μ F	C33	1 μ F
C15	1 μ F	C34	50 μ M F
C16	1 μ F	C35	
C17	1 μ F	C36	1 μ F
C18	15-45 μ M F	C37	0.1 μ F
C19	15-45 μ M F	C38-C43	100 μ M F
RESISTANCES			
R1	2 M Ω	R14	25,000 Ω
R2	500,000 Ω	R15	10,000 Ω
R3	500 Ω	R16	100,000 Ω
R4	10,000 Ω	R17	1 M Ω
R5	100,000 Ω	R18	1 M Ω
R6	50,000 Ω	R19	POT.
R7	25,000 Ω	R20	10,000 Ω
R8	500 Ω	R21	5,000 Ω
R9	50,000 Ω	R22	5,000 Ω
R10	10,000 Ω	R23	250,000 Ω
R11	100,000 Ω	R24	POT.
R12	50,000 Ω	R25	15,000 Ω
R13	500 Ω		

RECEIVER CIRCUIT DIAGRAM

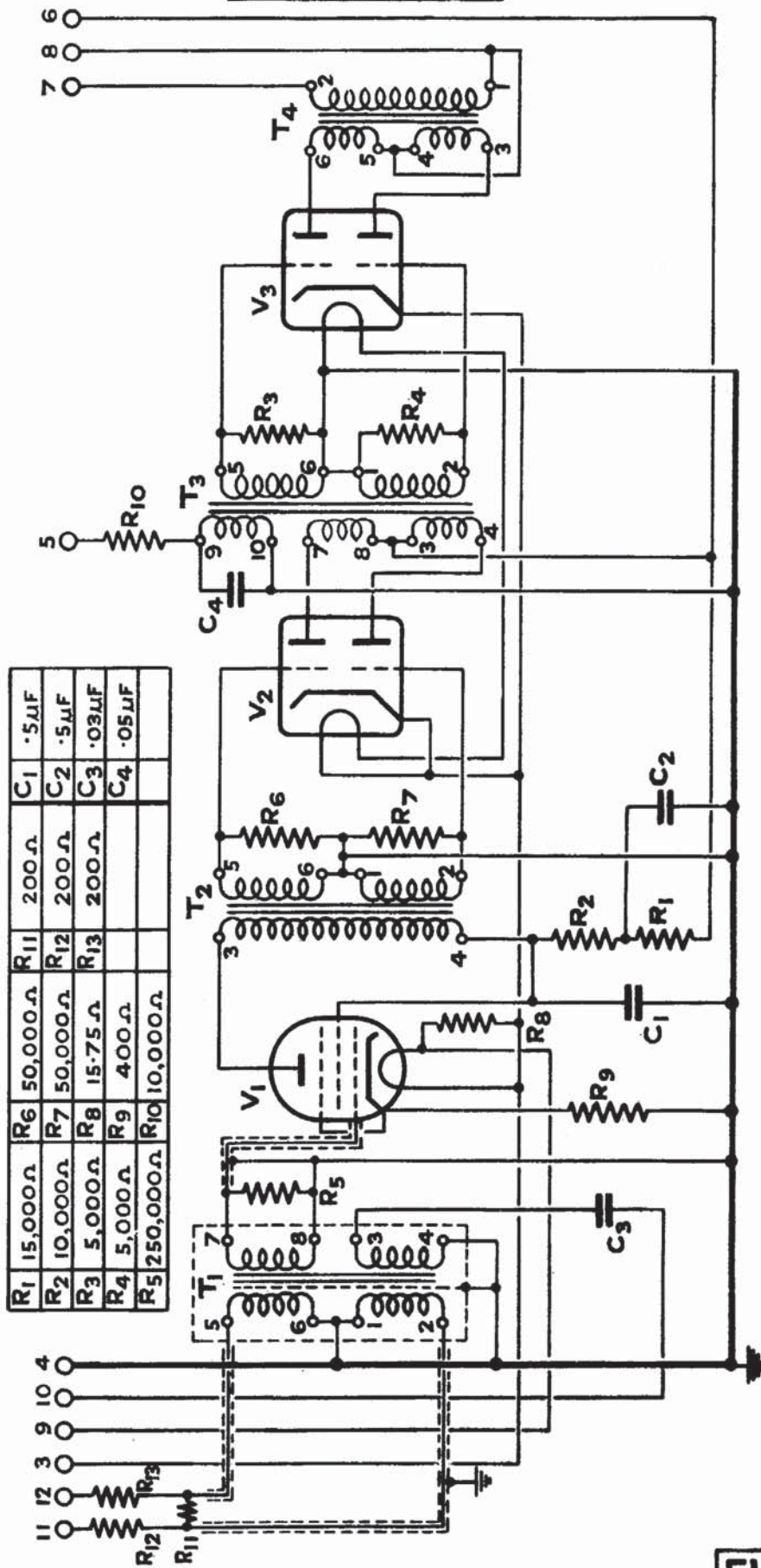


FIG. 5

FIG. 5

AMPLIFIER CIRCUIT DIAGRAM

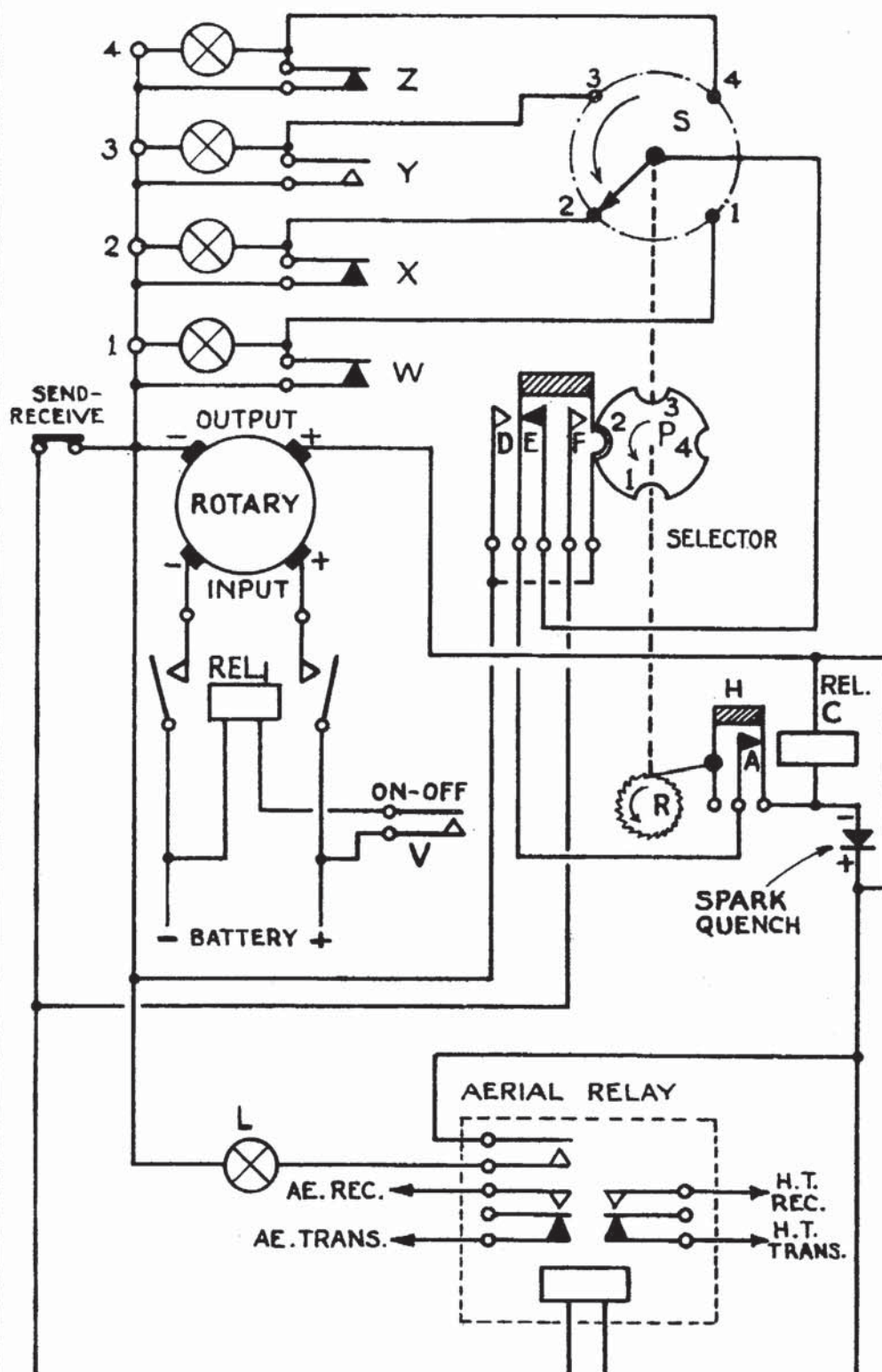


FIG. 6 CONTROL CIRCUITS-SIMPLIFIED DIAGRAM

FIG. 6

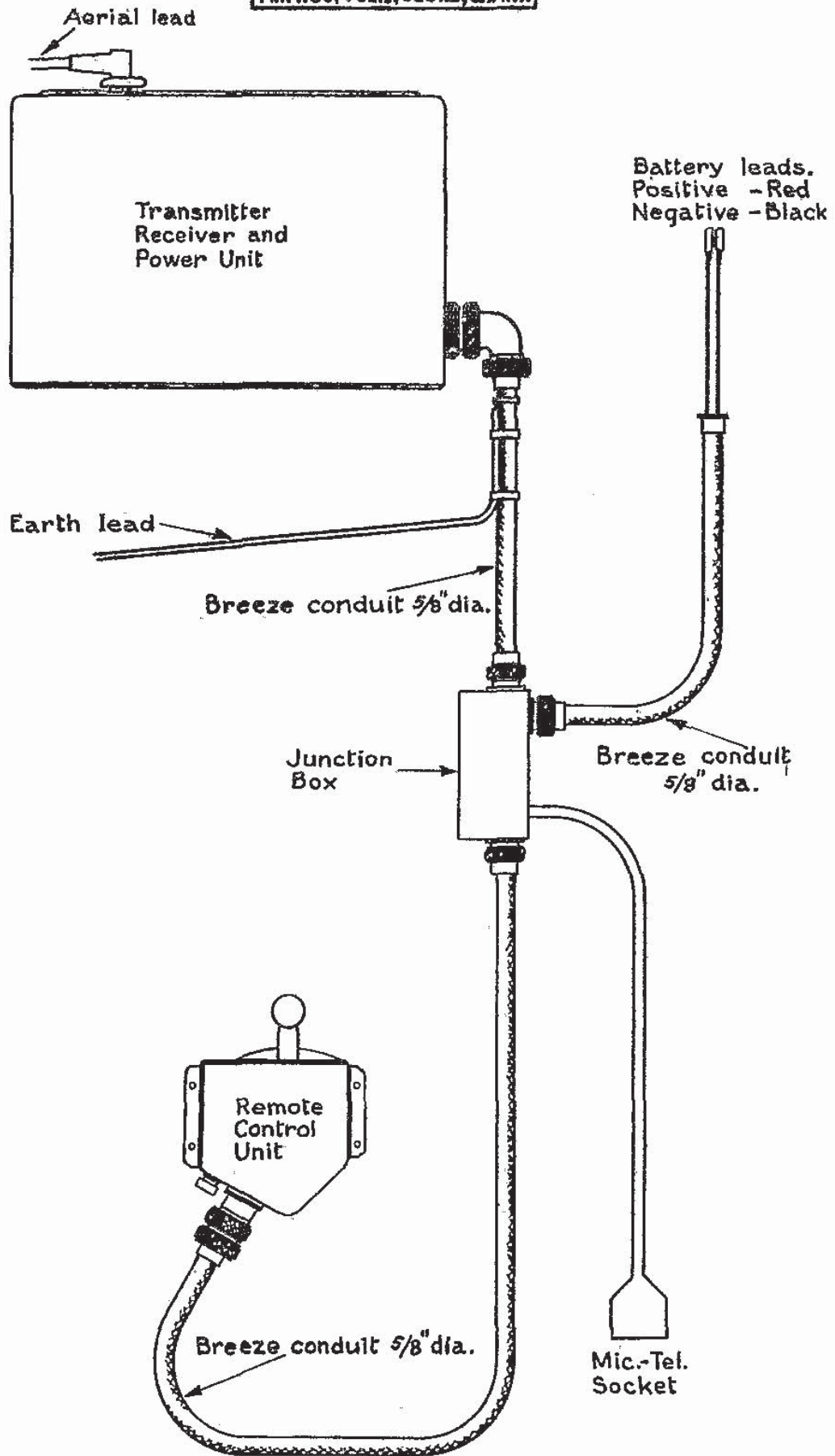


FIG. 7

INSTALLATION DIAGRAM

FIG. 7

19. All the power necessary for operating the entire equipment is obtained from this unit which is mounted on the main chassis. The principal component of this unit is a rotary transformer which is driven from the aircraft battery. Change from 12-volt to 24-volt operation or *vice-versa* is made by changing the rotary transformer, and it is only necessary to slide this out from the main unit and replace it with the alternative type.

20. The rotor of the transformer is fitted with three commutators—one for the L.T. input from the aircraft battery, and the other two for outputs of 12 volts and 300 volts respectively. Each circuit includes full R.F. smoothing for all windings and smoothing for L.F. ripple in the output windings. As will be seen from the theoretical circuit diagram, the smoothing arrangements consist of chokes in series with each winding and the input and output leads have condensers shunted across them. Complete screening is effected by enclosing the unit and its associated circuits in a metal case. Cooling is by means of a fan fitted to one end of the rotor. Fuses are provided in both input and output circuits.

21. Overload and starting relays are fitted. One of these REL. 2 is of the thermal type, designed to protect the machine against a sudden heavy overload or a prolonged small overload. The starter relay (REL. 1) is of the magnetic type and operates contacts in both input leads.

Remote control system

22. A simplified circuit diagram of the remote-control system is given in fig. 6. In both transmitter and receiver there are similar control mechanisms which operate in parallel when a single-lever control on the control unit is used.

23. The operation of the system can be most easily understood by taking a specific example and for this purpose it will be assumed that it is required to set the equipment in operation in position 3 of the control. This position on the actual control lever will be apparent from the photograph shown later (fig. 15). The lever is first moved to this position and this movement performs two functions.

- (i) When moved from the OFF position, the pair of contacts V shown in the simplified diagram (fig. 6) are closed.
- (ii) As the lever passes through each position, it momentarily opens a contact associated with the position (W, X, Y or Z), finally keeping open, in the instance being considered, the contact for position 3(Y).

24. The closing of contact V applies voltage from the aircraft battery to the coil of the relay (REL. 1), the contacts of which close and apply volts to the input of the rotary transformer.

25. As the rotary transformer comes up to speed, it builds up L.T. output volts which are applied to the operating coil C of the selector mechanism, through the circuit from "Rotary+", "Coil C", "Contact A", "Contact E", "Selector arm S" (which may be in any position, but is assumed for the purpose of this explanation not to be in position 3) and "Contact X" in the control unit, back to "Rotary—."

26. The coil C is energised and operates the arm H; when this has moved, contact A is broken, thus releasing the arm H which, being spring loaded, returns to its normal position, at the same time moving the ratchet wheel R one tooth. Ratchet wheel R, cam P and selector switch S are all on the same shaft and therefore move in unison.

27. The movement of cam P breaks contact E and makes D, with the result that the circuit to coil C is now through contact D and not through the selector arm and control unit.

28. Arm H continues to advance the ratchet wheel R a tooth at a time until the cam P arrives at the next notch, when contact D is again broken and contact E made, transferring the circuit to coil C back through the selector arm and control unit.

29. If the switch arm should be in position 3, which corresponds to the position selected by the arm of the control unit, the negative path is through a lamp, because the contacts which normally short circuit it are open. The resistance of the lamp is high in comparison with that of the coil C and therefore the major part of the voltage is developed across it, with the result that coil C is not energised to a sufficient extent to operate H, and R ceases to rotate.

30. If, however, the switch arm had not been in position 3, the negative path would have been directly through the control unit and the next impulse would have moved the cam P out of the notch and the sequence would have been repeated until such time as it fell into the correct notch. The selector switch S is therefore automatically rotated until it takes up the correct position as set up on the control unit.

Send-receive change-over

31. Change-over from SEND to RECEIVE or *vice versa* is effected by a push-button on the control unit which makes the change every time it is pressed and released. The switch which this

button operates is closed in the RECEIVE position and completes a circuit from the rotary transformer output to the operating coil of relay 1 of the aerial relay unit shown in the complete circuit diagram fig. 2.

32. This relay has three sets of contacts which switch:—

- (i) The aerial from the receiver to the transmitter.
- (ii) H.T. from the receiver to the transmitter.
- (iii) Lights lamp L on the control unit when in the SEND position.

33. In the RECEIVE position the relay is energised. To change over to SEND, the switch is broken, the relay de-energised and the aerial and H.T. are transferred from the receiver to the transmitter and the lamp L is lighted.

34. During the process of changing frequency, the aerial and H.T. are automatically put on to the receiver. This precaution is effected as follows:—During the change-over, cam P, fig. 6, is not resting in a "home" position and contact F is therefore closed, thus energising the aerial relay 1 of the aerial relay unit regardless of the position of the SEND-RECEIVE switch.

Aerial relay unit

35. The theoretical circuit diagram of the aerial relay unit is given in fig. 2. It consists of a coil-operated relay, with suitable contacts, which performs the following:—transfers the aerial from receiver to transmitter, transfers the H.T. supply from receiver to transmitter and, removes the H.T. from the final stage of the audio-frequency amplifier. These operations can, of course, be reversed when changing from TRANSMIT to RECEIVE. This unit also contains the breakdown resistances R_1 and R_2 which reduce the H.T. from 300 volts to 200 volts on RECEIVE. A meter adaptor is provided for checking aerial current. An approximate value of 0.9 amp. into a 5 ohms 100 $\mu\mu$ F aerial should be obtained.

CONSTRUCTIONAL DETAILS

General

36. A view of the complete transmitter-receiver with the outer case removed is given in fig. 8. The metal cover (*see* fig. 1) is secured by spring clips at (1) and when this is removed the five units—transmitter, receiver, audio-amplifier, power unit and aerial change-over unit, are accessible.

37. All these units are mounted on the main chassis to which they are secured by locking bars and studs. On the left of the chassis is the receiver unit (2) and attached to this, at the right, is a case containing the selector mechanism. On the right is the audio-frequency amplifier (3). Behind these units from left to right are the aerial relay unit, the transmitter (4) and the rotary transformer unit (5), the last named having a detachable cover, secured by screws, thus permitting easy access to the interior which in addition to the rotary transformer and its associated equipment also houses the starting relay.

Transmitter

38. A view of the transmitter is given in fig. 9. On the upper part of the chassis are mounted the anode and aerial tuning coils L_1 , L_2 , L_3 and L_4 and situated below these are the cases (1), containing the crystals. The valve V_1 at the front is the crystal controlled master oscillator and valve V_2 , at the rear is the R.F. amplifier. Sockets (2) are provided on the front of the chassis into which a grid meter may be inserted in order to check the master oscillator drive to the output. Devices for adjusting the aerial and anode coils are indicated at (3). A view of the underside of the transmitter is given in fig. 10.

Receiver

39. A general view of the receiver is given in fig. 11. On the front of the receiver chassis holes are provided for access to the aerial (C_3 to C_6) and H.F. (C_{10} to C_{13}) trimming condensers and L.F. and H.F. volume controls. Above these are the four cases (X_1 to X_4) containing the crystals for the four spot frequencies. The valves are at the rear, each being contained in its separate can provided with spring retained covers. From left to right, the valve sequence is H.F. amplifier, (V_1); frequency changer, (V_2); 1st I.F. amplifier, (V_3); 2nd I.F. amplifier, detector and A.V.C., (V_4). In front of the valves are the tuning inductances L_1 , L_2 , L_3 , L_4 . At the extreme right is the case (1) containing the selector mechanism. The underside of the receiver is given in fig. 12.

Audio-frequency amplifier

40. An exterior view of the audio-frequency amplifier unit is given in fig. 13. The main components, which include the microphone (T_1) and modulation (T_4) transformers and the three valves, are mounted on the top of the chassis. The valves, two of which are the same type as clearly shown, are the penultimate amplifier (V_1), the modulator (V_2) and the microphone amplifier (V_3). On the left is the plug assembly for connection to the main chassis.

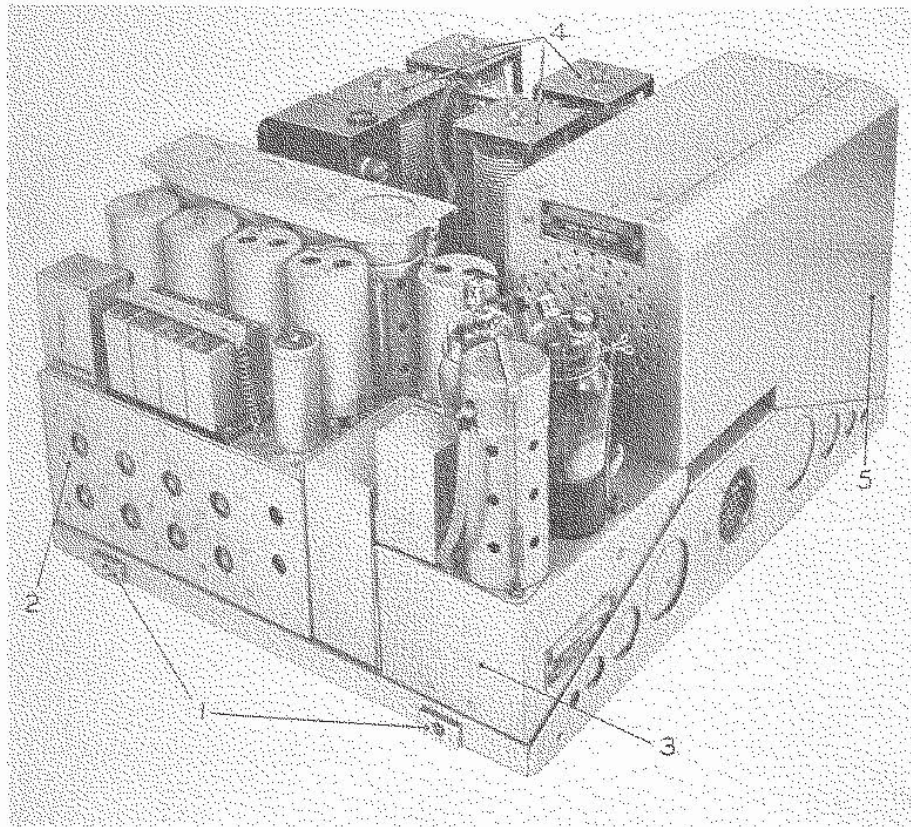


FIG. 8—VIEW OF MAIN UNIT

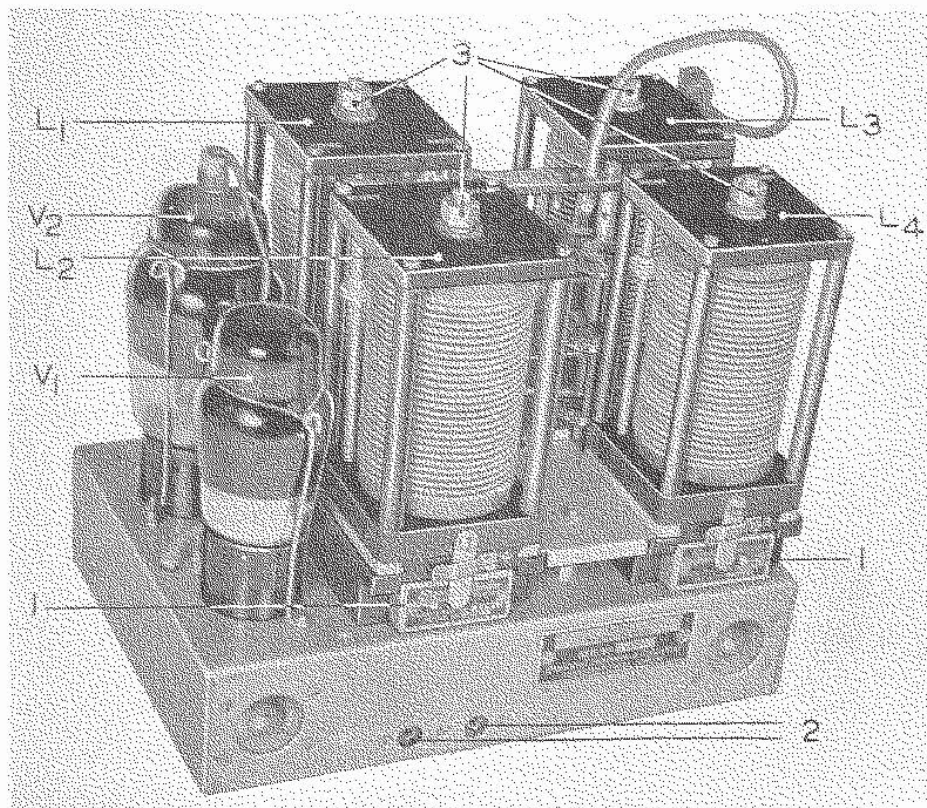


FIG. 9.—VIEW OF TRANSMITTER

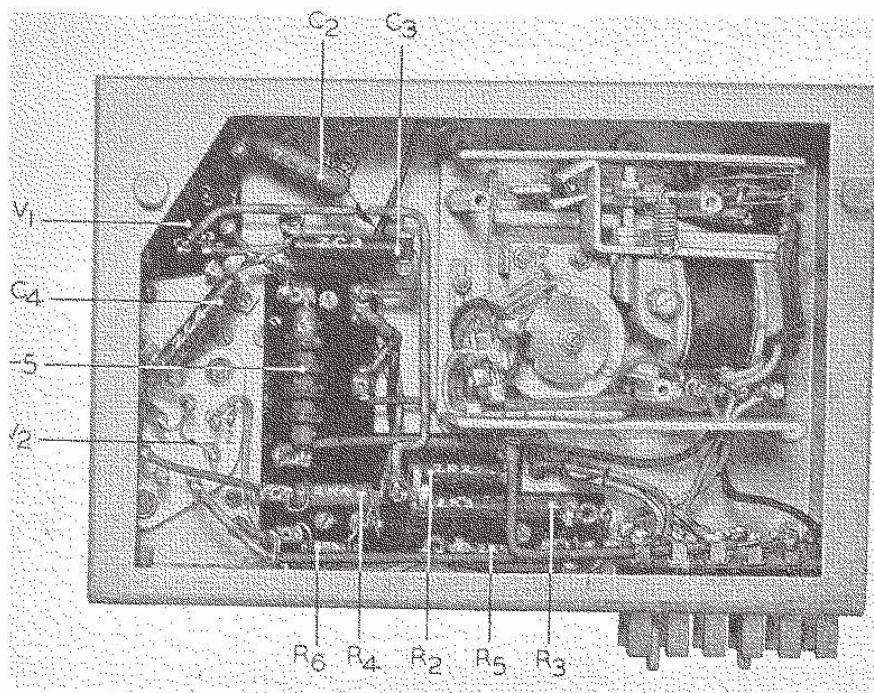


FIG. 10.—VIEW OF UNDERSIDE OF TRANSMITTER

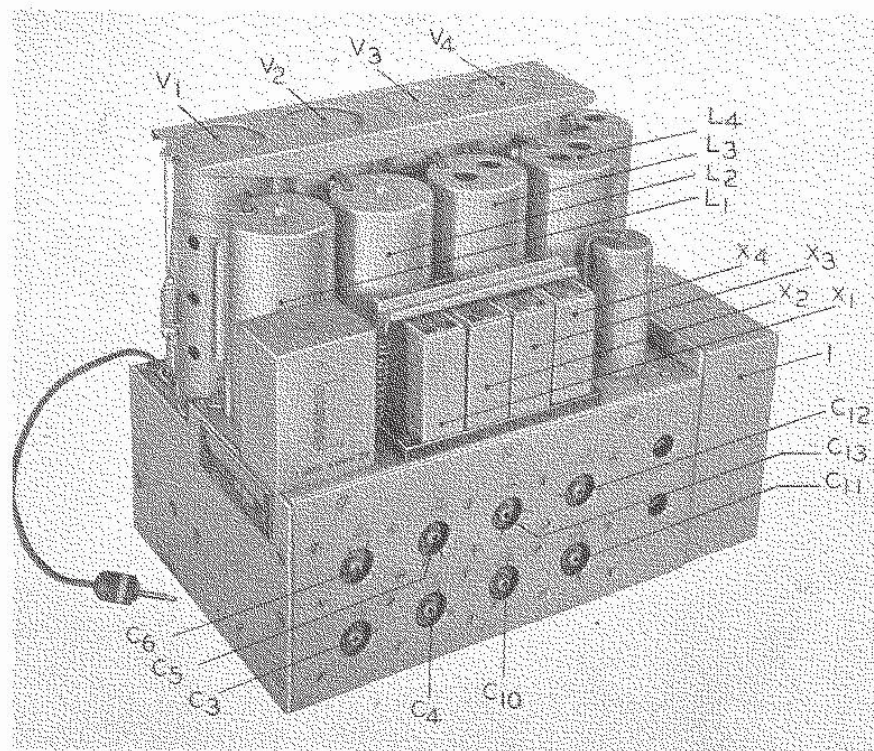


FIG. 11.—VIEW OF RECEIVER

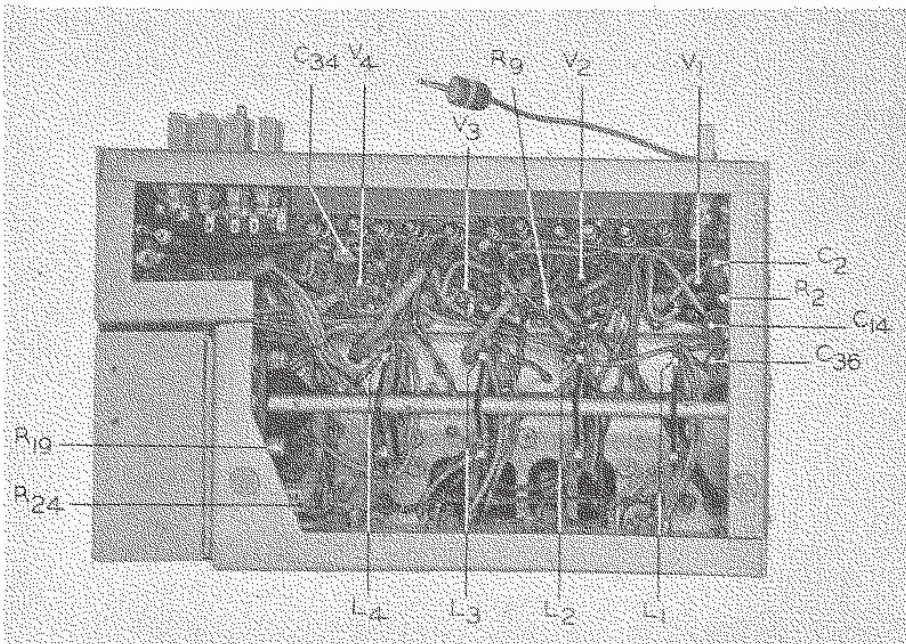


FIG. 12.—VIEW OF UNDERSIDE OF RECEIVER

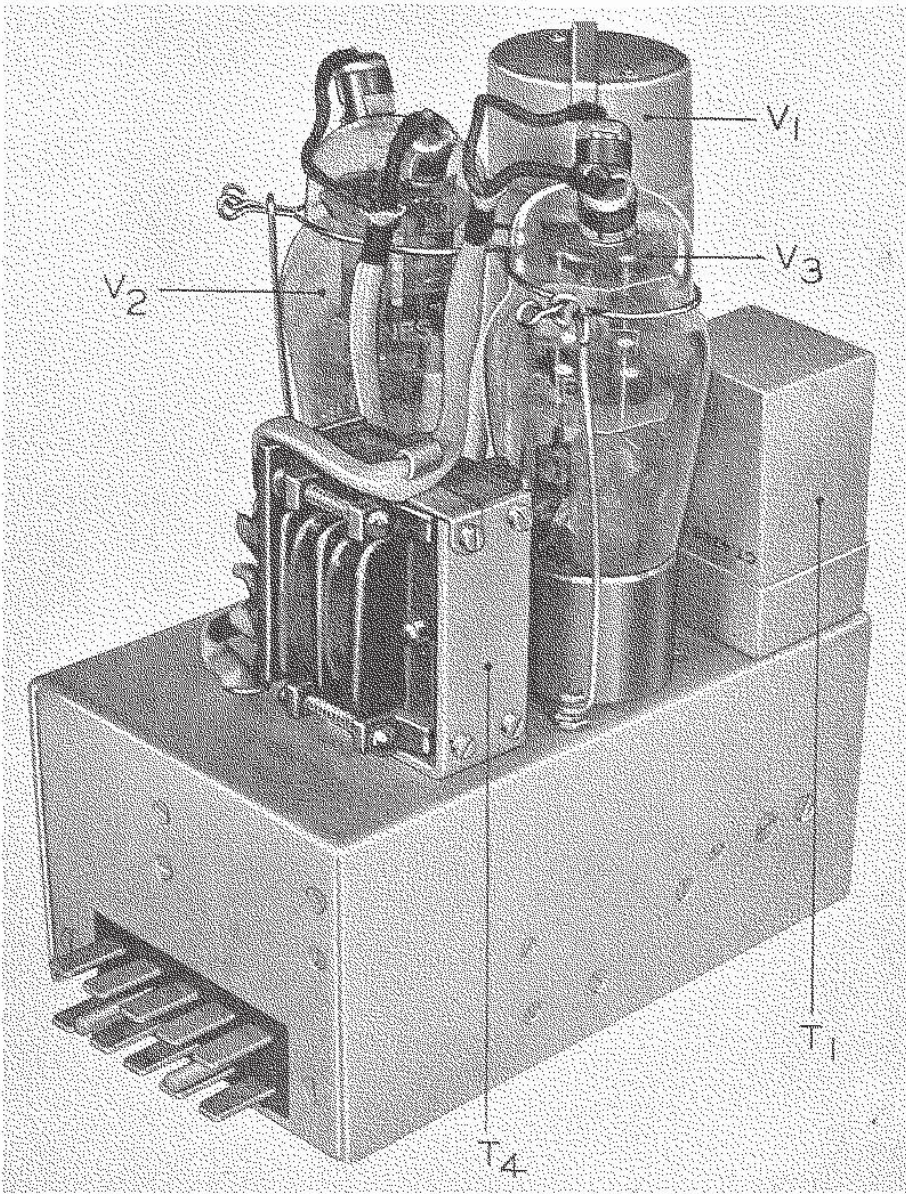


FIG. 13.—VIEW OF AUDIO-FREQUENCY AMPLIFIER

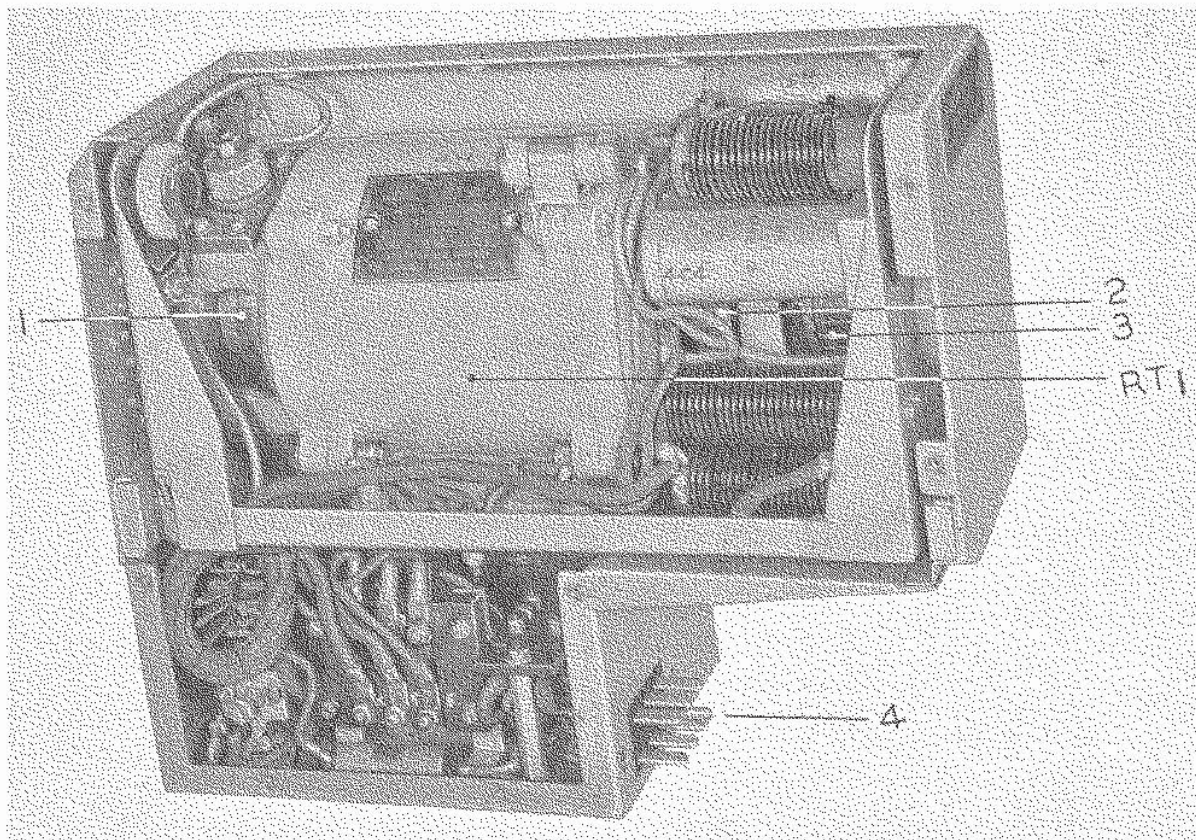


FIG. 14.—VIEW OF POWER UNIT

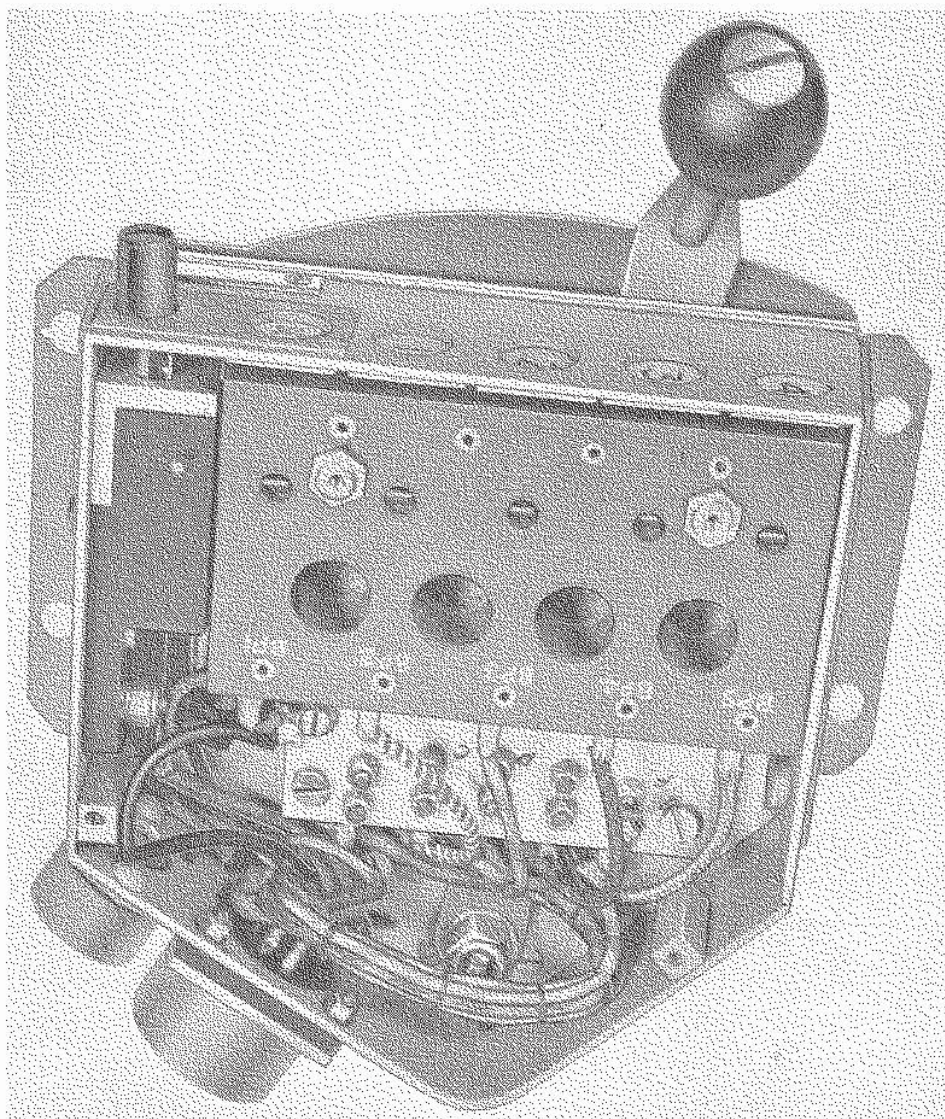


FIG. 15.—VIEW OF REMOTE-CONTROL UNIT

Power supply unit

41. Referring to fig. 14, which is a view of the interior of the power unit and its associated equipment, it will be seen that this is contained in a ventilated metal case with the rotary transformer RT_1 approximately in the centre, the H.F. filter on the extreme left and the L.F. smoothing for ripple at the right. In the compartment below is situated the starting relay. H.T. output is taken from the commutator (1) on the left, L.T. output from the inner commutator (2) on the right and the L.T. input is made at the outer commutator (3). The plugs for connection to the main chassis (4) project from the bottom compartment at the right. Incorporated in the power supply unit is an overload cut-out in the form of a thermal relay.

Remote control unit

42. The remote control switch unit is contained in a metal case which is entirely separate from the main unit to which it is connected by Breeze cable. A view of this is given in fig. 15. By removing four screws from the outer side of the control unit, this may be removed and access obtained to the whole of the interior. Removal of two screws from the external face and two screws from the lower part of the lamp assembly enables this to be withdrawn at the end of its connecting wires. To withdraw the lamps it is necessary to remove the external cover plate from the unit and slide the windows sideways in their slots. The lamps may then be withdrawn lengthwise from their sockets.

Selector mechanisms

43. The selector mechanisms are mounted, one on the transmitter and one on the receiver. They may be inspected in position by removing three small screws in the cases. If it is necessary to remove the complete mechanism, the three hexagon pillars which secure them to the rest of the unit should be removed.

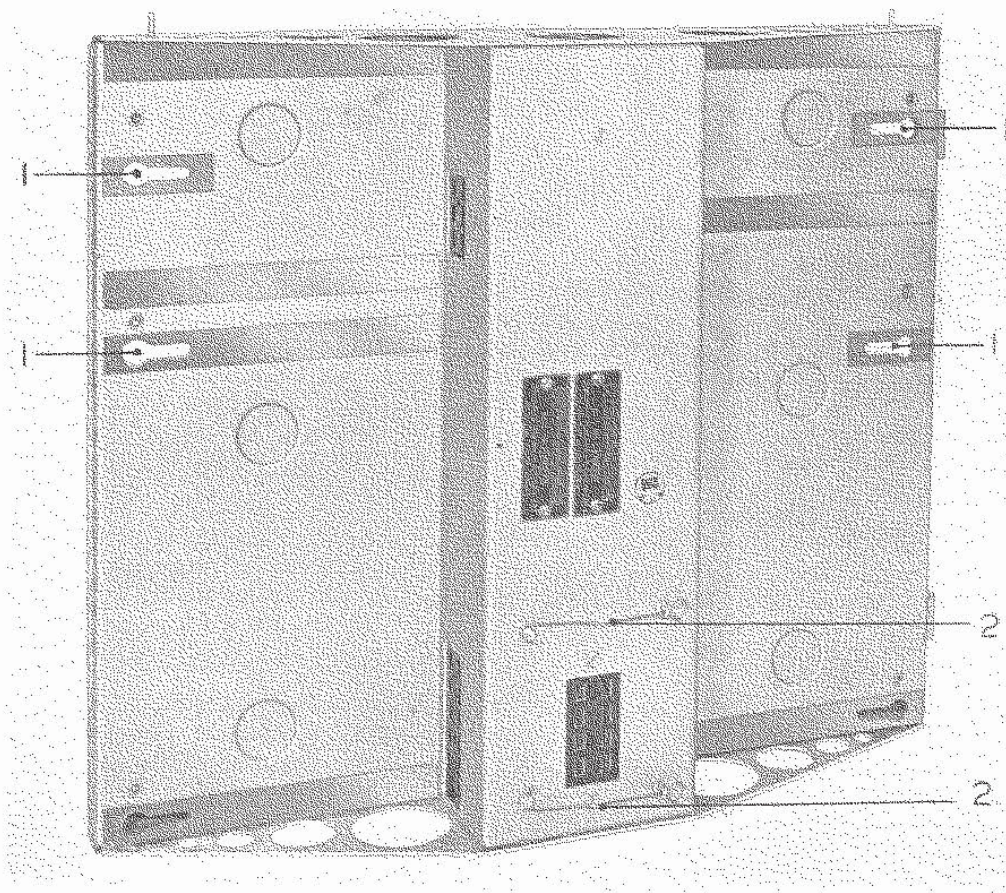


FIG. 16.—VIEW OF UPPER SIDE OF CHASSIS

Main chassis

44. The transmitter, receiver, audio-amplifier, and rotary transformer units are secured in position on the main chassis by locking studs and bars underneath the chassis. These bars can be seen at (1) in fig. 16. The aerial relay unit is retained in position by wire clips (2). The aerial leads from the transmitter and receiver are inserted into two sockets in the side of the aerial relay unit—the transmitter lead in the red socket and the receiver lead in the white socket.

VALVES AND POWER SUPPLY

45. The complete equipment incorporates nine valves, eight crystals and five lamps. The transmitter has two valves—a crystal oscillator type—6F6G pentode valve and a R.F. amplifier type—5B/300B.

46. The receiver employs four valves.— V_1 the R.F. amplifier is a type 6U7G pentode valve; V_2 the frequency changer, is a heptode, type 6K8G; V_3 the first I.F. amplifier is a pentode type 6U7G; and V_4 the second I.F. amplifier, detector and A.V.C. rectifier is a double diode pentode type 6B8G.

47. The audio-frequency amplifier has three valves.— V_1 is a valve type 6U7G, V_2 and V_3 are both double triodes, type 33A/100A.

48. The eight crystals employed—four in the transmitter and four in the receiver—are all of the same type. For transmitting and receiving on the same frequency, the receiver crystal is 470 kc/s. (I.F. frequency) below that of the transmitter crystal.

49. The rated power characteristics of the rotary transformer for the power supply are as follows:—

- (i) When connected to a 12-volt supply the 12-volt machine will deliver:—

120 mA. at 300 volts	} Transmit
3 amp. at 12.6 volts	
50 mA. at 300 volts	} Receive
3.5 amp. at 12.6 volts	
- (ii) When connected to a 24-volt supply the 24-volt machine will deliver:—

120 mA. at 300 volts	} Transmit
3 amp. at 13.1 volts	
50 mA. at 300 volts	} Receive
3.5 amp. at 13.1 volts	

50. It should be noted that the H.T. volts in the "Receive" condition are dropped to 200 by means of resistors contained in the aerial relay unit.

OPERATION

General

51. The units should be prepared for use according to the following instructions.

Transmitter

52. Plug in the valves and ensure that the retaining clips are in their correct positions. Insert the crystals in their appropriate sockets. The highest frequency crystal is normally situated in No. 1 socket and the other crystals follow in order of descending frequency. Care should be taken that the corresponding output coil is plugged in above each crystal. If there are different types of output coil included with the equipment, it should be remembered that the higher frequency coils will have fewer turns and greater spacing. It is necessary that the rollers are seated on the coil turns and not between them and that the retaining turn buttons are correctly in position.

Receiver

53. Plug in the valves according to the references marked on the chassis as follows:— V_1 , 6U7G; V_2 , 6K8G; V_3 , 6U7G; V_4 , 6B8G. Connect the grids and fit the retaining strip. The crystals should then be inserted in the same relative positions as for the transmitter, i.e., starting with the highest frequency in No. 1 holder. The crystal frequency is the output frequency less the I.F.

Audio-frequency amplifier

54. Plug in the 6U7G valve in the socket marked V_1 and place a screening can over it. Insert the two 33A/100A valves in the other two sockets and secure the anode clips in place. These clip leads are of such lengths that they reach the correct caps, and they should not be strained to fit any other.

Rotary transformer unit

55. Check that the H.T. and L.T. fuses are in their correct positions and that the screening box lid is firmly secured in place.

Main chassis tra

56. Fix the cover plate to the trough beneath the tray and then place the five units—transmitter, receiver, audio-frequency unit, rotary transformer unit and aerial relay unit in their respective positions. The aerial relay unit is retained by wire clips and the other units by locking studs and bars underneath the chassis. Plug the aerial leads from the transmitter and receiver into the two sockets in the side of the aerial relay unit—the receiver lead into the white socket and the transmitter lead into the red socket.

Connecting-up

57. The main chassis should now be placed in the aeroplane and the main cable inserted in the Breeze socket and screwed up. An aerial tuning meter is plugged into the aerial socket on the aerial relay unit and the aerial lead is inserted into the socket on the top of the meter. The earth lead is cut as short as possible and connected to the appropriate terminal on the frame of the aeroplane. For the purpose of preliminary tuning the lid should not be placed on the chassis.

58. Connect the battery cable to the battery. On moving the selector lever on the control unit from the OFF position, the rotary transformer should start up, the valves light, and the step-by-step mechanisms on the transmitter and receiver move round and come to rest in the corresponding positions, whereupon the signal light on the control unit will light up.

TUNING

Transmitter

59. Switch the equipment over to SEND on channel 1. Release the coil locking nut and place both tapping wheels at the top of the coil; rotate counter-clockwise until an indication is obtained on the aerial meter. Adjust the anode tap up or down for maximum output, retuning each time an adjustment is made. The anode tap must be as near the top of the coil as possible, consistent with maximum aerial current. If it is suspected that the crystal oscillator is not functioning, insert the grid current meter, mounted on the special plug provided, into the socket on the side of the transmitter. This will give a direct indication of drive.

60. To check modulation, plug in the headphone unit to the appropriate socket and speak into the microphone on "send" and note if the aerial current increases slightly and whether side tone is heard in the phones.

Receiver

61. Normally, the H.F. circuit of the receiver will have been carefully tuned for the frequencies specified and provided that the crystals have been inserted in the correct sockets, the trimmer condensers C_{10} to C_{13} should not be touched. The aerial circuit trimmer condensers C_3 to C_6 will have been tuned for an aerial capacity of 100 $\mu\mu$ F. in the laboratory and will probably require some slight adjustment. There are several methods of final tuning adjustment dependent upon the equipment available.

62. Should it be necessary to tune the H.F. circuits on noise, the following procedure is necessary to ensure tuning the correct channel. The trimmer, upon inspection, will be found to have a red line and a black line which, on rotation to coincide with a zero line, represent the high frequency or the low frequency end of the band respectively. Beginning with the condenser set on the black line (lower frequency end of the band), rotate slowly until a noise peak is heard. This is the second channel position. Ignore this and continue rotation until the second peak is found. This is the correct position and should be carefully tuned. In the case of a signal close to the lower end of the band, it might be found that only one noise peak can be located, in which case this may be assumed to be correct.

63. For tuning on output, if any type of output meter is available which can be substituted for the headphones, the two circuits may be tuned for maximum reading in the meter. It is not recommended that tuning be done on a basis of maximum speech level in the headphones. All tuning should be carried out with the aerial correctly connected.

64. Finally, in two-seater installations, check that speech in one microphone is heard in the other pair of headphones. Close down the equipment, disconnect the connection to the main chassis, withdraw, replace the lid of the equipment and return to position with the aerial current meter in place. Lift the two flaps in the lid above the transmitter and check the four transmitter output coils for tuning; some slight readjustment may be necessary owing to the presence of the lid. When maximum aerial current has been obtained, lock the coils with the hexagon locking nut, switch off and remove the aerial meter. Then replace the aerial in its normal socket and close the two flaps.

65. The equipment is now ready for operation, provided that all the leads are connected and the headphones plugged into the appropriate socket. Before the battery is connected, the control lever on the control unit should be in the OFF position.

66. To start up the equipment, move the control lever from its OFF position to the channel on which it is desired to transmit and receive. The signal light opposite to this position will light up, indicating that the wave-change switches have reached their correct positions. A short warming up period should be allowed.

67. The small button at the rearmost edge of the control unit changes over the equipment from RECEIVE to SEND or *vice versa*. When the equipment is set for transmitting, the white window marked SEND is illuminated red. Pressing the SEND-RECEIVE button and releasing it again, changes over from one operating condition to the other. It is not necessary to hold the button down for transmission; this is only necessary when a special "Press to talk" button is supplied.

68. If the equipment has been arranged for independent control of receive and transmitter communication channels, a control unit having two knobs of different colours will be fitted. The right-hand knob controls the starting and stopping of the equipment and the transmitter frequency, while the left-hand knob controls the receiver frequency only. The receiver knob is inoperative in its OFF position.

69. The provision of an external SEND-RECEIVE switch, which is wired into the control box, in no way affects the control of the equipment; it is used in place of the button fitted to the control unit.

70. Should the equipment be operated on an excess voltage for too long a period it is automatically protected by the operation of the thermal overload relay. It is still possible to use the equipment when the input voltage is excessive. Should the relay operate during communication, the equipment must be switched off for a period of not less than half a minute.

PRECAUTIONS AND MAINTENANCE

General

71. The transmitter-receiver is carefully aligned before going into service and it is most important, therefore, that the tuned circuits are not interfered with in any way except by competent personnel equipped with adequate apparatus. Repairs, adjustments and tests for faults should only be made when they are obvious and can be carried out with simple tools which are normally available.

72. *To remove units from main tray.—*

- (i) Remove the dust cover by undoing the four holding catches.
- (ii) Release both locking bars which are situated on the underside of the tray.
- (iii) Withdraw the unit about $\frac{3}{8}$ in., when the locking studs may be disengaged from the tray and the unit lifted out.

73. *To remove valves and coils from transmitter.—*The valves are retained by wire clips which can easily be unlocked. The screws securing these clips should not be removed.

74. The coils are provided with dovetail shaped bases and are held in position by a twin-button catch. When the catch is turned the coils can be slid forward. The catch serves the double purpose of securing the coil and retaining the crystal case in the compartment below.

75. *To remove valves and crystals from receiver.—*The valves in the receiver unit are all held in place by springs inside the valve can caps, which in turn are held in place by a spring-retained channel placed over the tops of the four cans. The crystal holders are secured by a similar device and when this is pulled forward, the crystal cases can be pulled upwards.

76. One side of the chassis is hinged to permit of inspection and servicing and it can be opened by removing the single countersunk screw at each end of the chassis.

77. *To remove valves from amplifier.—*The valves of the amplifier unit are retained by wire clips and anchored cams and can readily be removed by releasing these.

78. *To remove rotary transformer.—*The cover of the rotary transformer unit is removed by taking out the screws round its edge. Disconnection of the five leads from the terminal panel, which connects to the upper part of the unit, will permit the whole upper deck carrying the rotary transformer to be withdrawn. The sub-panel at one end of the rotary transformer, carrying certain of the smoothing components, is hinged, allowing it to be tilted back for complete removal of the machine should this be necessary.

79. *To replace fuses.—*Access to the fuse panel may be had through the hole in the bottom of the complete power supply unit. A 500-mA. fuse is fitted in the H.T. holder and a 10-amp. fuse in the L.T. holder.

Periodic inspection

80. *Daily.*

- (i) Check fully the operation of the equipment.
- (ii) Check connections of the aerial system.

- (iii) Check aerial insulators for security.
 - (iv) Check engagement of plugs and sockets on all units.
 - (v) Check microphone and headphone cords for loose connections or damage.
 - (vi) Check that remote control lever operates correctly.
81. *After every ten hours flying time.—*
- (i) Clean the rotary transformer commutators with carbon tetrachloride and ensure that the brushes are bedding down properly and the pigtail connections are secure.
 - (ii) Clean the wiping contacts in the remote control unit.
 - (iii) Check that all units are securely locked in place on the main tray.
82. *After every 25 hours flying time.—*
- (i) Remove all units from the main chassis and inspect for loose connections, screws, nuts and components.
 - (ii) Put a few drops of non-freezing oil on the selector relay oiling wicks (transmitter and receiver).
 - (iii) Check all relay contacts for burning or dirt.
 - (iv) Examine all earth connections for loose or dry joints.
 - (v) Examine valves and ensure that pins are a tight fit in sockets.
 - (vi) Examine all shock absorber mountings.
 - (vii) Check all currents for which jacks are provided and log.
 - (viii) Examine aerial wire for frayed or broken strands.
 - (ix) Clean all plug contacts and check for good electrical connection inside plugs.
 - (x) Check the bonding of all cables, including screening to engine and spark plugs.
 - (xi) Clean all cams.
 - (xii) Check signal-to-noise ratio on the receiver.
 - (xiii) Check power output and percentage modulation of the transmitter.

Location of faults

83. The following paragraphs indicate the faults which are most likely to develop and the manner of locating them without the use of special apparatus.

84. *No output from transmitter on one frequency.—*
- (i) Check that crystal is oscillating by the use of the grid meter. If no reading is obtained, substitute another crystal.
 - (ii) Examine rollers on coil and if dirty clean with carbon tetrachloride. Ensure that rollers rest on the coil turns and not between.
85. *No output or low output on all transmitter frequencies.—*
- (i) Check L.T. and H.T. voltages.
 - (ii) Examine all battery and rotary transformer connections. Check voltages at valve sockets.
 - (iii) If no H.T. voltage, check fuse.
 - (iv) If H.T. voltage present, check by measuring the feed current which should be approximately 120 mA.
 - (v) Clean all plugs and contacts with carbon tetrachloride and ensure that they are mechanically sound.
 - (vi) Check valves by substitution.
86. *No output from receiver on one frequency.—*
- (i) Check crystal by substitution.
 - (ii) Examine all switch and plug contacts.
 - (iii) Check condensers for the inoperative frequency.
87. *No output or low output from receiver on all frequencies.—*
- (i) Check fuse.
 - (ii) Ensure that volume control is not set at minimum.
 - (iii) Check all voltages at valve sockets.

- (iv) Check all valves by substitution.
- (v) Examine wiring for loose or dry joints. Wiring or components must not be disturbed in any way whatever, otherwise misalignment and serious loss of performance will result.

88. *Faulty operation of audio-frequency unit when input from microphone circuit or output from receiver is correct.*—

- (i) Check valves by substitution.
- (ii) Check continuity of transformers.
- (iii) Check continuity of screened leads and examine for short circuits between inner conductor and sheathing.

89. *Remote control.*—Clean dirty contacts with carbon tetrachloride. Ensure that all contacts have a good follow when operated by hand. Lubricate moving parts with non-freeze oil. Do not interfere with the adjustment of the step-by-step mechanism and associated relays. Failure of the SEND window to light indicates that either the aerial relay is not operating, or that the lamp or lamp circuit is faulty. The operation of the SEND-RECEIVE switch can be checked by removing the lamp mounting bank from the control unit and verifying that the switch closes in the RECEIVE position.

90. *Rotary transformer unit.*—Failure of the rotary transformer to start may be due to:—

- (i) Insufficient battery voltage,
- (ii) Dirty commutator or bearings.
- (iii) Short circuit in secondary.

In the last case the excessive current taken by the rotary transformer on starting up will operate the thermal relay connected with the primary circuit and the machine will be immediately shut down; it will not start again until the relay has cooled down.

Damage to crystals—over-excitation

91. Trouble has been experienced resulting in damage to crystals due to over-excitation. The screen potential on the oscillator valve should therefore be reduced. This can be done by changing over the two resistances R_2 and R_3 (fig. 3) so that $R_2 = 40,000$ ohms and $R_3 = 15,000$ ohms. This will not affect the efficiency of the transmitter.

92. Filter condensers C_4 , C_5 , C_6 , C_7 , and C_8 in the power unit (fig. 2) which were $2\mu F$ in later models are $1.5\mu F$ 50-volt working. (A.L.52)

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/611	Transmitter-receiver T.R.1304			
	Consisting of:—			
10F/1029	Aerial relay unit	1		
10U/96	Amplifier	1		
10L/65	Control unit	1		
10A/1388	Junction box	1		
10K/646	Power unit	1		
10P/46	Receiver	1		
10F/13005	Selector unit	1		
10R/62	Transmitter	1		
5E/81	Cables	3		
	Aerial relay unit			
	Principal components:—			
	Condenser			
10C/3055	Type 1465	1	C ₁	0.01 μ F, 2,200 V. D.C. test
	Relay			
10F/13006	Type 347	1	REL 1	
	Resistance			
10C/7178	Type 7178	2	R ₁ R ₂	5,000 ohms
	Amplifier		Ref. in fig.	
	Principal components:—			
	Condenser			
10C/8007	Type 130	2	C ₁ , C ₂	0.5 μ F, 350 V. working
10C/4902	Type 2594	1	C ₃	0.03 μ F, paxolin
10C/4119	Type 2118	1	C ₄	0.05 μ F, paxolin
	Holder, valve			
10H/1154	Type 132	3		
	Resistance			
10C/1721	Type 1721	1	R ₁	15,000 ohms
10C/1736	Type 1736	1	R ₂	10,000 ohms
10C/6397	Type 6397	2	R ₃ , R ₄	5,000 ohms, $\frac{1}{2}$ W.
10C/6982	Type 6982	1	R ₅	250,000 ohms, $\frac{1}{2}$ W.
10C/1301	Type 1301	2	R ₆ , R ₇	50,000 ohms, $\frac{1}{2}$ W.
10C/7224	Type 7224	1	R ₈	15.75 ohms
10C/6994	Type 6994	1	R ₉	400 ohms, $\frac{1}{2}$ W.
10C/1736	Type 1736	1	R ₁₀	10,000 ohms, $\frac{1}{2}$ W.
10C/1175	Type 1175	3	R ₁₁ , R ₁₂ , R ₁₃	200 ohms, $\frac{1}{2}$ W.
	Transformer			
	Type	1	T ₁	
	Type	1	T ₂	
	Type	1	T ₃	
	Type	1	T ₄	
	Valves			
10E/627	Type 6U7G	1	V ₁	
10E/629	Type 33A/100A	2	V ₂ , V ₃	
	Control unit		Ref. in fig. 2	
	Principal components:—			
	Lamp			
5L/1141	Type P.O.2A	5	P ₁ , P ₂ , P ₃ , P ₄ , P ₅	12 V.
	Power unit			
	Principal components:—			
	Condenser			
	Type	1	C ₁	0.002 μ F, 2,200 V. D.C. test
10C/4652	Type 2437	1	C ₂	1 μ F, 350 V. working
10C/3086	Type 1492	1	C ₃	0.1 μ F, paxolin
10C/3324	Type 1630	5	C ₄ , C ₅ , C ₆ , C ₇ , C ₈	2 μ F, 50 V. D.C. working
	Type	1	C ₉	1 μ F, paxolin
	Fuse			
10H/238	Type 29	1	F ₁	500 mA
10H/13034	Type 88	1	F ₂	10 A
	Inductance			
	Type	4	L ₁ , L ₂ , L ₃ , L ₄	
	Relay			
10F/534	Type 230	1	REL.1	
10F/1030	Type 15	1	REL.2	Thermal

Ref. No.	Nomenclature	Qty.	Ref. in fig. 5	Remarks
	Transmitter receiver T.P.1304 (contd.)			
	Power Unit (contd.)			
	Principal components (contd.)			
10K/650	Transformer Type 53	1	T.R.1	Rotary
	Receiver			
	Principal components:—		Ref. in fig. 4	
	Condenser			
10C/10749	Type 459	1	C ₁	0.0001 μ F
10C/10165	Type 386	1	C ₂	0.1 μ F, paxolin
10C/4705	Type 2476	4	C ₃ , C ₄ , C ₅ , C ₆	7-110 $\mu\mu$ F
10C/10165	Type 386	2	C ₇ , C ₈	0.1 μ F, paxolin
	Type	1	C ₉	3 $\mu\mu$ F, disc type
10C/4705	Type 2476	4	C ₁₀ , C ₁₁ , C ₁₂ , C ₁₃	7-110 $\mu\mu$ F trimmers
10C/10165	Type 386	4	C ₁₄ , C ₁₅ , C ₁₆ , C ₁₇	0.1 μ F paxolin
	Type	2	C ₁₈ , C ₁₉	15 $\mu\mu$ F-45 $\mu\mu$ F trimmers
10C/10165	Type 386	4	C ₂₀ , C ₂₁ , C ₂₂ , C ₂₃	0.1 μ F paxolin
	Type	2	C ₂₄ , C ₂₅	15 $\mu\mu$ F-45 $\mu\mu$ F trimmers
10C/10165	Type 386	2	C ₂₆ , C ₂₇	0.1 μ F paxolin
10C/10749	Type 459	1	C ₂₈	0.0001 μ F
	Type	2	C ₂₉ , C ₃₀	15 $\mu\mu$ F-45 $\mu\mu$ F
10C/9755	Type 332	1	C ₃₁	0.01 μ F paxolin
	Type	1	C ₃₂	0.00005 μ F
10C/10165	Type 386	1	C ₃₃	0.1 μ F paxolin
10C/8386	Type 176	1	C ₃₄	50 $\mu\mu$ F ceramic
	Type	1	C ₃₅	350 V. working
10C/10165	Type 386	1	C ₃₆	0.1 μ F paxolin
10C/9755	Type 332	1	C ₃₇	0.01 μ F paxolin
10C/4705	Type 2476	6	C ₃₈ , C ₃₉ , C ₄₀ , C ₄₁ , C ₄₂ , C ₄₃	100 $\mu\mu$ F silvered mica
	Crystal			
	Type	4	X ₁ , X ₂ , X ₃ , X ₄	Frequency as specified
10H/1154	Holder, valve			
	Type 132	4		
	Inductance			
	Type	2	L ₁ , L ₂	Tuning coil
	Type	1	L ₃	Tuning coil
	Type	1	L ₄	Tuning coil
	Type	1	L ₅	Tuning coil
10C/5007	Type 409	1	L ₆	Choke 3.2 H. 40 mA, 360 ohms
	Resistance			
10C/7011	Type 7011	1	R ₁	2 megohms, $\frac{1}{2}$ W.
10C/7022	Type 7022	1	R ₂	500,000 ohms, $\frac{1}{2}$ W.
10C/6118	Type 6118	1	R ₃	500 ohms, $\frac{1}{2}$ W.
10C/6343	Type 6243	1	R ₄	10,000 ohms, $\frac{1}{2}$ W.
10C/1900	Type 1500	1	R ₅	100,000 ohms, $\frac{1}{2}$ W.
10C/6005	Type 6005	1	R ₆	50,000 ohms, $\frac{1}{2}$ W.
	Type	1	R ₇	25,000 ohms, $\frac{1}{2}$ W.
10C/6118	Type 6118	1	R ₈	500 ohms, $\frac{1}{2}$ W.
10C/6005	Type 6005	1	R ₉	50,000 ohms, $\frac{1}{2}$ W.
10C/6343	Type 6343	1	R ₁₀	10,000 ohms, $\frac{1}{2}$ W.
10C/1900	Type 1500	1	R ₁₁	100,000 ohms, $\frac{1}{2}$ W.
10C/6005	Type 6005	1	R ₁₂	50,000 ohms, $\frac{1}{2}$ W.
10C/6118	Type 6118	1	R ₁₃	500 ohms, $\frac{1}{2}$ W.
10C/1899	Type 1899	1	R ₁₄	20,000 ohms, $\frac{1}{2}$ W.
10C/6343	Type 6343	1	R ₁₅	10,000 ohms, $\frac{1}{2}$ W.
10C/1900	Type 1500	1	R ₁₆	100,000 ohms, $\frac{1}{2}$ W.
10C/1198	Type 1198	2	R ₁₇ , R ₁₈	1 megohm, $\frac{1}{2}$ W.
10C/7455	Type 7455	1	R ₁₉	Potentiometer
10C/7202	Type 7202	1	R ₂₀	1,000 ohms, $\frac{1}{2}$ W.
10C/7181	Type 7181	1	R ₂₁	5,000 ohms, $\frac{1}{2}$ W.
10C/10898	Type 443	1	R ₂₂	5,000 ohms, $\frac{1}{2}$ W.
10C/6982	Type 6982	1	R ₂₃	250,000 ohms, $\frac{1}{2}$ W.
10C/6998	Type 6998	1	R ₂₄	Potentiometer
10C/6985	Type 6985	1	R ₂₅	15,000 ohms, $\frac{1}{2}$ W.
	Valves			
10E/622	Type 6U7G	1	V ₁	
10E/405	Type 6K8G	1	V ₂	
10E/622	Type 6U7G	1	V ₃	
10E/406	Type 6B8G	1	V ₄	

Ref. No.	Nomenclature	Qty.	Ref. in fig. 4	Remarks
	Transmitter receiver T.R.1304 (<i>contd.</i>)			
	Selector unit		Ref. in fig. 2	
	Principal components:			
	Rectifier			
	Type	1	W_1	
	Transmitter		Ref. in fig. 3	
	Principal components:—			
	Condenser			
10C/7902	Type 121	1	C_1	0.0001 μ F
10C/8496	Type 188	1	C_2	0.01 μ F
10C/8010	Type 133	3	C_3, C_4, C_5	0.002 μ F 2,200 V. D.C. test
	Crystal, type A	4	X_1, X_2, X_3, X_4	Frequency as specified
	Holder, valve,	2		
10H/353	Type 59	1		
10H/1154	Type 132	1		
	Inductance			
	Type	4	L_1, L_2, L_3, L_4	
10C/2360	Type 104	1	L_5	H.F. choke, 1.25 μ H
	Resistance			
10C/1818	Type 924	1	R_1	100,000 ohms, $\frac{1}{2}$ W.
10C/7175	Type 7176	1	R_2	15,000 ohms
10C/6425	Type 6425	1	R_3	40,000 ohms
10C/8021	Type 113	1	R_4	20,000 ohms, $\frac{1}{2}$ W.
10C/7177	Type 7177	1	R_5	2.4 ohms
10C/1758	Type 1758	1	R_6	50 ohms, $\frac{1}{2}$ W.
	Valve			
10E/346	Type 6F6G	1	V_1	
10E/628	Type 5B300B	1	V_2	